



# AGA10x

## Central-i DC Power Amplifier

### Product Manual



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Member of Akribis Systems group

## Revision History

| Version | Description                                                                                                                                                                        | Date          |
|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| 1.1     | Deleted: AGA101 sin/cos configuration option on Aux Encoder port in Technical Specifications.<br>Added: AGA103 isolated digital output circuit diagram.<br>Minor text corrections. | 4 August 2021 |
| 1.0     | Initial release                                                                                                                                                                    | 2 August 2021 |

## Contact Information

Manufacturer Agito Akribis Systems Ltd., Member of Akribis Systems Group  
Address 6 Yad-Harutsim St., P.O.Box 7172, Kfar-Saba 4464103, Israel  
Telephone +972-9-8909797  
Website [www.agito-akribis.com](http://www.agito-akribis.com)

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## Warranty

This product is warranted to be free of defects in material and workmanship and conforms to the specifications listed in this manual, for a period of 12 months from the shipment date from factory.

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# 1 Product Description

## 1.1 General Description

The AGA10x is a series of DC amplifiers controlled by an AGM series Central-i master. The master controller reads encoder values and current samples from the amplifiers, performs control loops calculation, and generates PWM commands for the amplifiers.

Communication between AGA10x amplifiers and master controller is through a fast Central-i fieldbus, which supports 16 kHz sample rate motion profiler and all servo loops.

The amplifiers are equipped with digital I/Os and analog inputs suitable for typical actuators and applications. The digital outputs are capable of sourcing up to 300 mA or sinking up to 500 mA, which is sufficient for driving most external devices and end effectors, and eliminates the need for an external relay circuit.

The AGA10x amplifiers are compact, ideal for mounting close to the actuator, such as the link in an articulated robot arm.



Figure 1. AGA10x amplifier series

## 1.2 Part Numbering

### 1.2.1 AGA101 Product Variants

| Product Description | Part Number Format |
|---------------------|--------------------|
| Remote amplifier    | AGA101-CI-2Dxx     |

**CI:** Central-i *communication*

**2D:** 12–90 VDC power supply

**xx:** Continuous and peak current options

- **01:** 1.4 A<sub>rms</sub> continuous, 2.8 A<sub>rms</sub> peak
- **02:** 2.8 A<sub>rms</sub> continuous, 5.6 A<sub>rms</sub> peak
- **05:** 5.6 A<sub>rms</sub> continuous, 11.2 A<sub>rms</sub> peak

**Example:** AGA101-CI-2D02 indicates 2.8 A<sub>rms</sub> continuous current and 5.6 Arms peak current

### 1.2.2 AGA102 Product Variants

| Product Description | Part Number Format |
|---------------------|--------------------|
| Amplifier           | AGA102-CI-1Dxx     |

**CI:** Central-i communication

**1D:** 12—48 VDC power supply

**xx:** Continuous and peak current options

- **01:** 1.4 A<sub>rms</sub> continuous, 2.8 A<sub>rms</sub> peak
- **02:** 2.8 A<sub>rms</sub> continuous, 5.6 A<sub>rms</sub> peak
- **05:** 5.6 A<sub>rms</sub> continuous, 11.2 A<sub>rms</sub> peak

**Example:** AGA102-CI-1D05 indicates 5.6 A<sub>rms</sub> continuous current and 11.2 A<sub>rms</sub> peak current

### 1.2.3 AGA103 Product Variants

| Product description | Part numbers   |
|---------------------|----------------|
| Amplifier           | AGA102-CI-1D03 |

**CI:** Central-i communication

**1D:** 12—48 VDC power supply

The AGA103 has no product variants. It has 2.8 Arms continuous current and 5.6 Arms peak current.

## 1.3 System Design

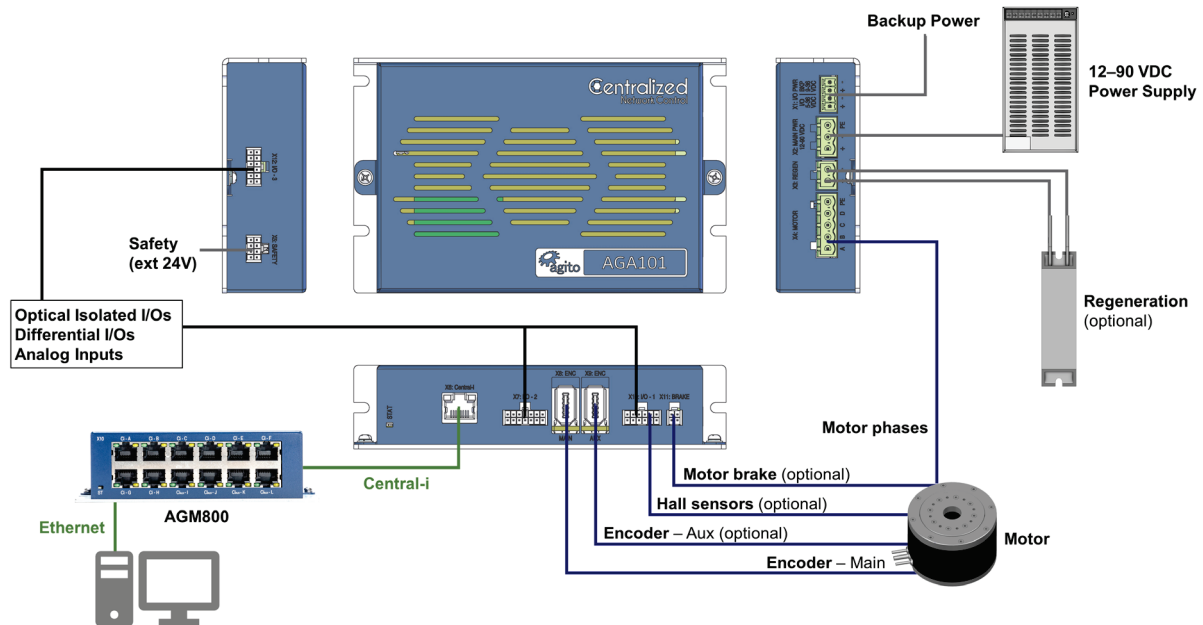


Figure 2. AGA101 system connections and wiring

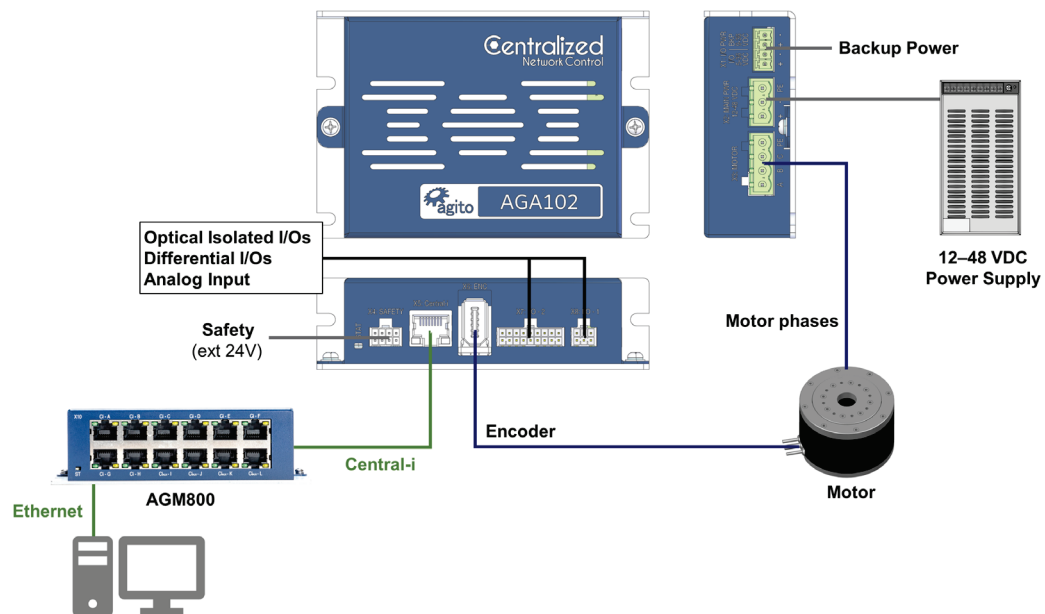


Figure 3. AGA102 system connections and wiring

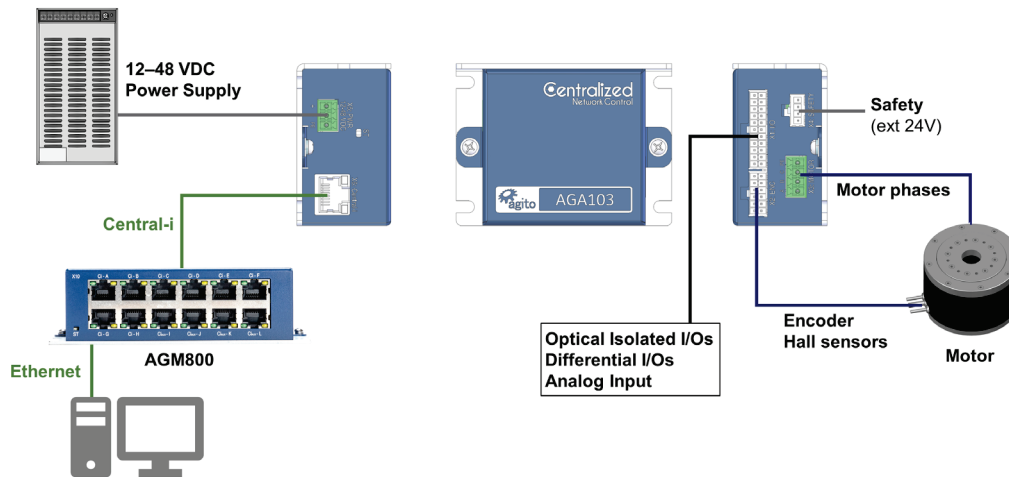


Figure 4. AGA103 system connections and wiring

## 1.4 Technical Specifications

### Electrical/Mechanical Specifications

| Feature                                                                     | Specification                                                         |                                                                       |                                                                       |
|-----------------------------------------------------------------------------|-----------------------------------------------------------------------|-----------------------------------------------------------------------|-----------------------------------------------------------------------|
|                                                                             | AGA101                                                                | AGA102                                                                | AGA103                                                                |
| Number of axes                                                              | 1                                                                     | 1                                                                     | 1                                                                     |
| Power supply                                                                | 12-90 VDC                                                             | 12-48 VDC                                                             | 12-48 VDC                                                             |
| Continuous output current ( $A_{rms}$ )<br>(internally limited by firmware) | 1.4   2.8   5.6                                                       | 1.4   2.8   5.6                                                       | 2.8                                                                   |
| Peak output current ( $A_{rms}$ )<br>(Internally limited by firmware)       | 2.8   5.6   11.2                                                      | 2.8   5.6   11.2                                                      | 5.6                                                                   |
| Peak current time                                                           | 3 sec                                                                 | 3 sec                                                                 | 3 sec                                                                 |
| Output frequency                                                            | 0 – 599 Hz                                                            | 0 – 599 Hz                                                            | 0 – 599 Hz                                                            |
| Over-current protection ( $A_{rms}$ )                                       | 10   20   40                                                          | 10   20   40                                                          | 20                                                                    |
| Isolated digital inputs (see Note 1)                                        | 11                                                                    | 7                                                                     | 5                                                                     |
| Isolated digital outputs (see Note 2)                                       | 3                                                                     | 2                                                                     | 2 (see Note 3)                                                        |
| Bi-directional differential I/Os (RS422)                                    | 1                                                                     | –                                                                     | –                                                                     |
| Analog inputs                                                               | 2 (12-bit)                                                            | 1 (12-bit)                                                            | 1 (12-bit)                                                            |
| Analog outputs                                                              | –                                                                     | –                                                                     | –                                                                     |
| PT100                                                                       | –                                                                     | –                                                                     | 1                                                                     |
| Brake outputs                                                               | 1                                                                     | –                                                                     | –                                                                     |
| Regeneration outputs                                                        | 1                                                                     | –                                                                     | –                                                                     |
| Encoder port - Main                                                         | Configurable as AqB, Sin/Cos 1Vpp, Absolute BiSS-C, Absolute EnDat2.2 | Configurable as AqB, Sin/Cos 1Vpp, Absolute BiSS-C, Absolute EnDat2.2 | Configurable as AqB, Sin/Cos 1Vpp, Absolute BiSS-C, Absolute EnDat2.2 |

| Feature                          | Specification                                                                                          |                                                                                                        |                                                                                                        |
|----------------------------------|--------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|
|                                  | AGA101                                                                                                 | AGA102                                                                                                 | AGA103                                                                                                 |
| Encoder port - Auxiliary         | Configurable as AqB, Absolute BiSS-C, Absolute EnDat2.2                                                | –                                                                                                      | –                                                                                                      |
| Motor types                      | Voice coil.<br>Brushed/brushless linear/rotary.<br>2-phase stepper (open/closed loop, micro-stepping). | Voice coil.<br>Brushed/brushless linear/rotary.<br>2-phase stepper (open/closed loop, micro-stepping). | Voice coil.<br>Brushed/brushless linear/rotary.<br>2-phase stepper (open/closed loop, micro-stepping). |
| Communication                    | Central-i                                                                                              | Central-i                                                                                              | Central-i                                                                                              |
| PWM frequency                    | 16 kHz                                                                                                 | 16 kHz                                                                                                 | 16 kHz                                                                                                 |
| Power supply to external devices | Voltage: 5V<br>Overall max. current: 0.5A                                                              | Voltage: 5V<br>Overall max. current: 0.5A                                                              | Voltage: 5V<br>Overall max. current: 0.5A                                                              |

Note 1: Digital isolated inputs can be configured as NPN or PNP, in groups of 3 or 4.

Note 2: Digital isolated outputs can sink up to 500 mA or source up to 300 mA.

Note 3: AGA103: digital isolated outputs can be configured only as NPN (sink).

### Encoder Ports Specifications

| Feature                   | Specification                                                                                                                                                                                      |
|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Encoder types             | Incremental AqB, Sin/Cos<br>Absolute: EnDat 2.2, BiSS-C                                                                                                                                            |
| Power supply to encoder   | AGA101: 0.5A per encoder port<br>AGA102: 0.5A per encoder port<br>AGA103: 0.3A per encoder port                                                                                                    |
| Max. cable length         | 20 m                                                                                                                                                                                               |
| Incremental encoder (AqB) | Hardware: Differential RS422/RS485<br>Max. input frequency: 6.25 MHz<br>Termination: 120 $\Omega$<br>Commutation: Auto-phasing, Hall sensors                                                       |
| Sin/Cos encoder           | Hardware: Differential RS422/RS485, 1V pk-pk @2.5V<br>Max. input frequency: 250 kHz<br>Termination: 120 $\Omega$<br>Max interpolation: 13 bits (x 8192)<br>Commutation: Auto-phasing, Hall sensors |
| Absolute BiSS-C           | Hardware: Differential RS422/RS485, clock (MA), data (SLO)<br>Clock frequency: 1 MHz<br>Max. position bits: 32 bits<br>Commutation: Auto-phasing, by absolute offset                               |

| Feature            | Specification                                                                                                                                             |
|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| Absolute EnDat 2.2 | Hardware: Differential RS422/RS485, clock, data<br>Clock frequency: 1 MHz<br>Max. position bits: 32 bits<br>Commutation: Auto-phasing, by absolute offset |
| Hall sensors       | Opto-isolated 5V with internal or external power supply                                                                                                   |

### I/O Specifications

| Feature                                  | Specification                                                                                                                                                                                    |
|------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Power supply for optically isolated I/Os | Voltage: 5-28 VDC                                                                                                                                                                                |
| Optically isolated digital inputs        | Type: PNP/NPN<br>Propagation delay: 10 $\mu$ s<br>Max. frequency: 100 kHz<br>Functionality: limit switches, home, captures, start motion, gain scheduling, and others                            |
| Optically isolated digital outputs       | Type: PNP/NPN<br>Max current: 0.5A (for NPN type), 0.3A (for PNP type)<br>Propagation delay: 10 $\mu$ s<br>Max. frequency: 100 kHz<br>Functionality: alarm, in-position, event (PEG), and others |
| Differential digital inputs              | Hardware: Differential RS422<br>Propagation delay: 100 ns<br>Max. frequency: 2 MHz<br>Functionality: lock (capture), pulse and direction, Handwheel                                              |
| Analog inputs                            | Operational voltage: $\pm$ 10V<br>Resolution: 12 bit                                                                                                                                             |
| Static brake output                      | Operational voltage: 24V<br>Maximum current: 3A                                                                                                                                                  |

### Central-i Specifications

| Feature                       | Specification                                                                |
|-------------------------------|------------------------------------------------------------------------------|
| Topology                      | Star (peer to peer)                                                          |
| Cycle time                    | 61 $\mu$ s                                                                   |
| Connector type                | RJ-45 (Cat5e cable)                                                          |
| Cable length                  | Up to 20 m<br>Longer cables, up to 100 m, are possible with special hardware |
| Physical layer                | Dual channel RS485 full duplex                                               |
| Baud rate                     | 20 Mbps (per channel)                                                        |
| Synchronization between nodes | 8 nanosecond                                                                 |

## AGA101 Dimensions and Weight

| Feature               | Specification                  |
|-----------------------|--------------------------------|
| Unit dimensions (max) | H=162 mm, W=36.50 mm, D=102 mm |
| Package dimensions    | W=210 mm x W=50 mm x D=140 mm  |
| Unit weight           | 306 g                          |
| Shipping weight       | 410 g                          |

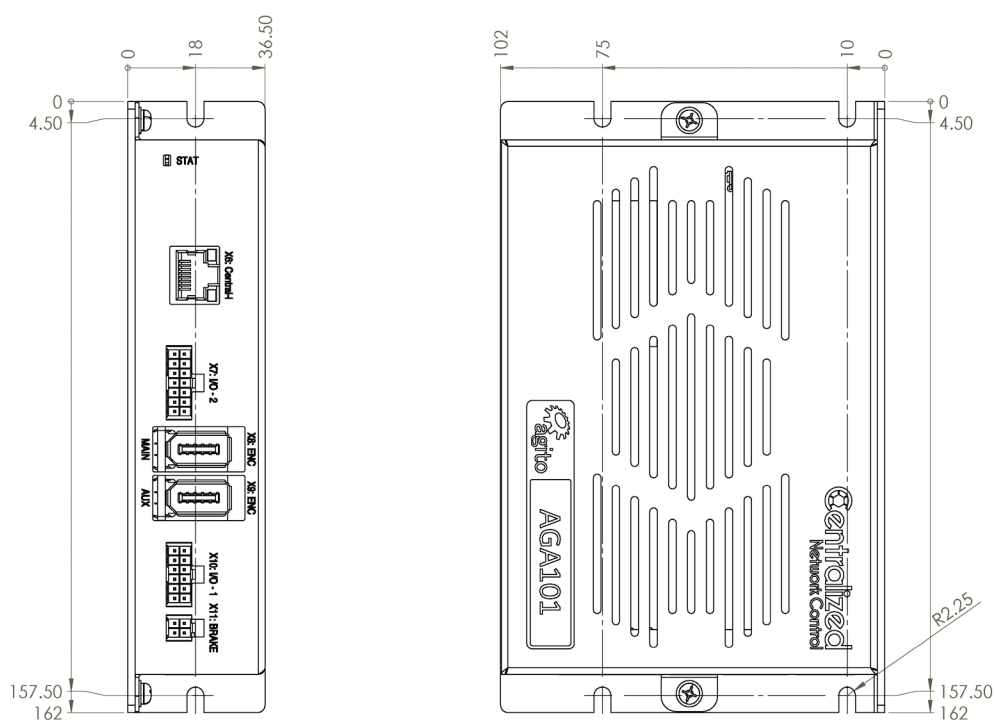


Figure 5. AGA101 dimensions (mm)

### AGA102 Dimensions and Weight – AGA102

| Feature               | Specification                 |
|-----------------------|-------------------------------|
| Unit dimensions (max) | H=120 mm, W=33 mm, D=82 mm    |
| Package dimensions    | H=170 mm x W=50 mm x D=120 mm |
| Unit weight           | 200 g                         |
| Shipping weight       | 286 g                         |

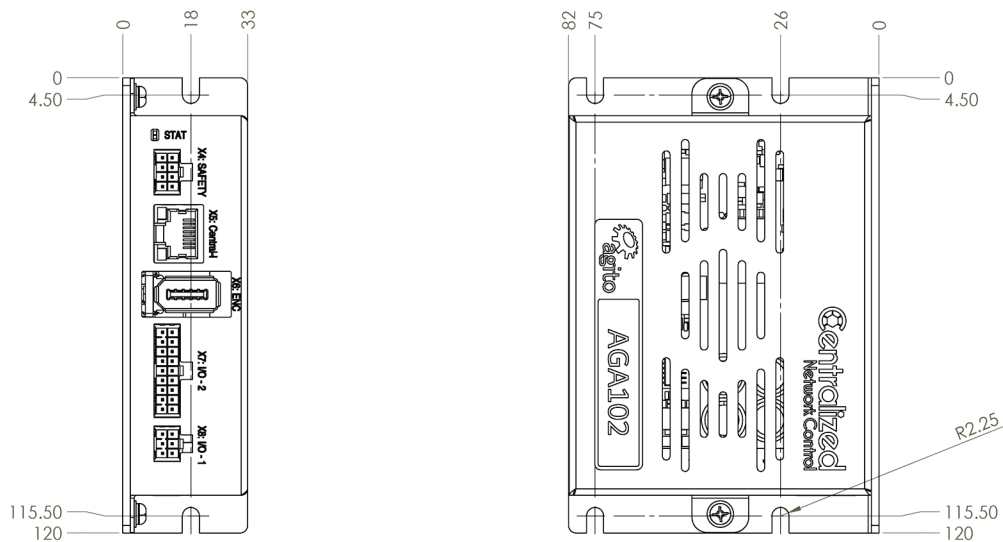


Figure 6. AGA102 dimensions (mm)

### AGA101 Dimensions and Weight

| Feature               | Specification                 |
|-----------------------|-------------------------------|
| Unit dimensions (max) | H=80 mm, W=35 mm, D=60 mm     |
| Package dimensions    | H=170 mm x W=50 mm x D=120 mm |
| Unit weight           | 118 g                         |
| Shipping weight       | 204 g                         |

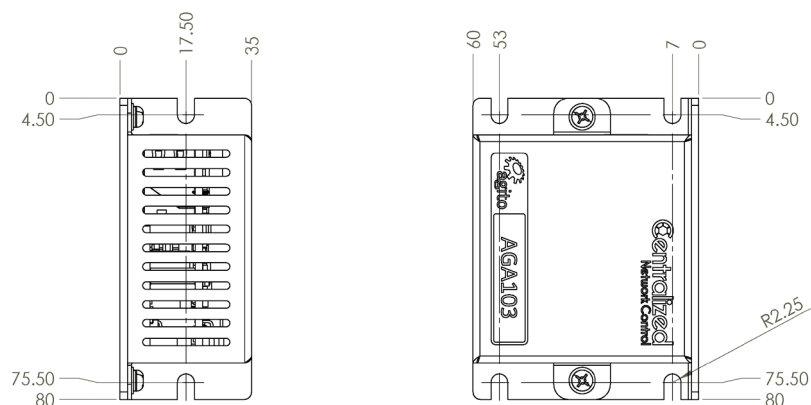


Figure 7. AGA103 Dimensions (mm)

## 1.5 Environmental Specifications

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The operational range may be additionally limited by the internal temperature protection of the product. It is the user's responsibility to avoid operating the product in environmental conditions that do not conform to the defined limits.

### Environmental Specifications

| Feature                         | Specification                                                     |
|---------------------------------|-------------------------------------------------------------------|
| Operating (ambient) temperature | 0°C to 50°C                                                       |
| Storage temperature             | -20°C to 70°C                                                     |
| Operating humidity              | < 90%                                                             |
| Storage humidity                | < 40%                                                             |
| Pollution degree                | 2                                                                 |
| Vibration*                      | per 1G @ 150 Hz according to IEC 60068-2-6 – <i>under testing</i> |
| Operating conditions            | IP20                                                              |

## 2 Safety

### 2.1 Safety Symbols

Safety symbols indicate a potential for personal injury or equipment damage if the prescribed precautions and safe operating practices are not followed.

The following safety symbols are used in the product documentation.

#### Safety Symbols

| Symbol                                                                            | Meaning                        | Description                                                                                                                                                                                           |
|-----------------------------------------------------------------------------------|--------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | Hazardous voltage              | Indicates hazards arising from dangerous voltages.                                                                                                                                                    |
|  | Earthing PE (protective earth) | Identifies any terminal which is intended for connection to an external conductor for protection against electric shock in case of a fault, or the terminal of a protective earth (ground) electrode. |
|  | Caution, hot surface           | Indicates the marked item can be hot and should not be touched without taking care.                                                                                                                   |

### 2.2 Safety Guidelines

To achieve optimum and safe operation of the product, it is important to follow the safety procedures specified in this manual.

- Only qualified personnel may install, maintain, or repair the product. Before starting installation, maintenance or operation, ensure that all system components are connected to protective earth ground (PE).
- The PE wire must be colored green-yellow, in accordance with local electrical wiring standards.
- This product contains electrostatic-sensitive components. Proper handling procedures must be observed to avoid damage to the product.
- To avoid electric arcing and hazards, never connect or disconnect any connector while the power source is on.
- The maximum power supply voltage connected to the product must comply with the ratings provided in this manual.
- Always disconnect the power cables before servicing the product.
- Pay attention to safety symbols on the product or in the manual. Follow proper safety precautions when installing or operating the product.



#### Attention

All power connectors must be securely tightened before any operation.



#### Warning

Power, Motor, and Regeneration interfaces are high power. Do not touch these connectors when the amplifier is powered.

**Warning**

Capacitors on the DC bus can retain hazardous voltages after input power has been removed.

**Attention**

Do not attempt to hinder or override the product's or system's fault detection or protection circuits. You must determine the cause of a fault and correct it before you attempt to operate the system. Failure to correct the fault could result in personal injury and/or damage to equipment.

## 2.3 Compliance

### Standards Compliance

| Description                                          | Standard      |
|------------------------------------------------------|---------------|
| Safety requirements – Electrical, thermal and energy | IEC-61800-5-1 |
| EMC requirements and specific test methods           | IEC-61800-3   |

This product is intended to operate in a machine or equivalent end-product. The machine or end-product must comply with any necessary safety standard as typically required for the same type of machine or end-product. It is the responsibility of the machine or end-product manufacturer to ensure the final machine or end-product meets the requirement of any safety and EMC regulations.

## 3 Installation

---

### 3.1 Unpacking and Packing

---

Save the original box and packing materials in case you need to pack and return the product to the manufacturer.

To unpack the product:

1. Carefully remove the product from the box and the packing materials.
2. Visually inspect the product to ensure that there is no damage. If any damage has occurred, report it immediately to the carrier that delivered the package.
3. After unpacking, locate the part number label on the product, and make sure it matches the product you ordered, and that the voltage meets your specific requirements.

### 3.2 Mounting

---

#### 3.2.1 Mounting the AGA10x

---

The heatsink on the back of the AGA10x includes holes/slots for mounting the unit.

The AGA10x is mounted using 2 M4 screws. It is important to mount the product on metal panel for both grounding and secure connections.

The heatsink of the AGA10x is electrically conductive and serves as the protective earth (PE) ground of the product. However, it is critical to ensure the PE screws are electrically conducting between the PE of AGA10x and the PE of main power supply in the system. For details, refer to the section Grounding.

All cables connected to the product must be securely constrained to avoid vibration that causes stress concentration at the cables or connectors which may result in breakage of electrical conductivity.



#### Warning – Metal Base Plate for Heat Dissipation

---

The product is supplied with the mounting plate built into the heatsink. At full power operation, the heat sink can be quite warm, around 45°C. It is recommended to mount the product on a large metal panel to help dissipate the heat generated in the product.

### 3.2.2 Mounting Multiple Power Amplifiers

When mounting multiple amplifiers within a cabinet, clearance between units must be at least 5 mm. In addition, top and bottom clearance must be at least 50 mm.

Ambient temperature in the cabinet must not exceed limit defined in the section *Environmental Specifications*.

If amplifiers are mounted on a backplane, the backplane temperature must not exceed the ambient limit defined in the section *Environmental Specifications*.

It is recommended to install a cooling fan at the bottom of the cabinet for best circulation.

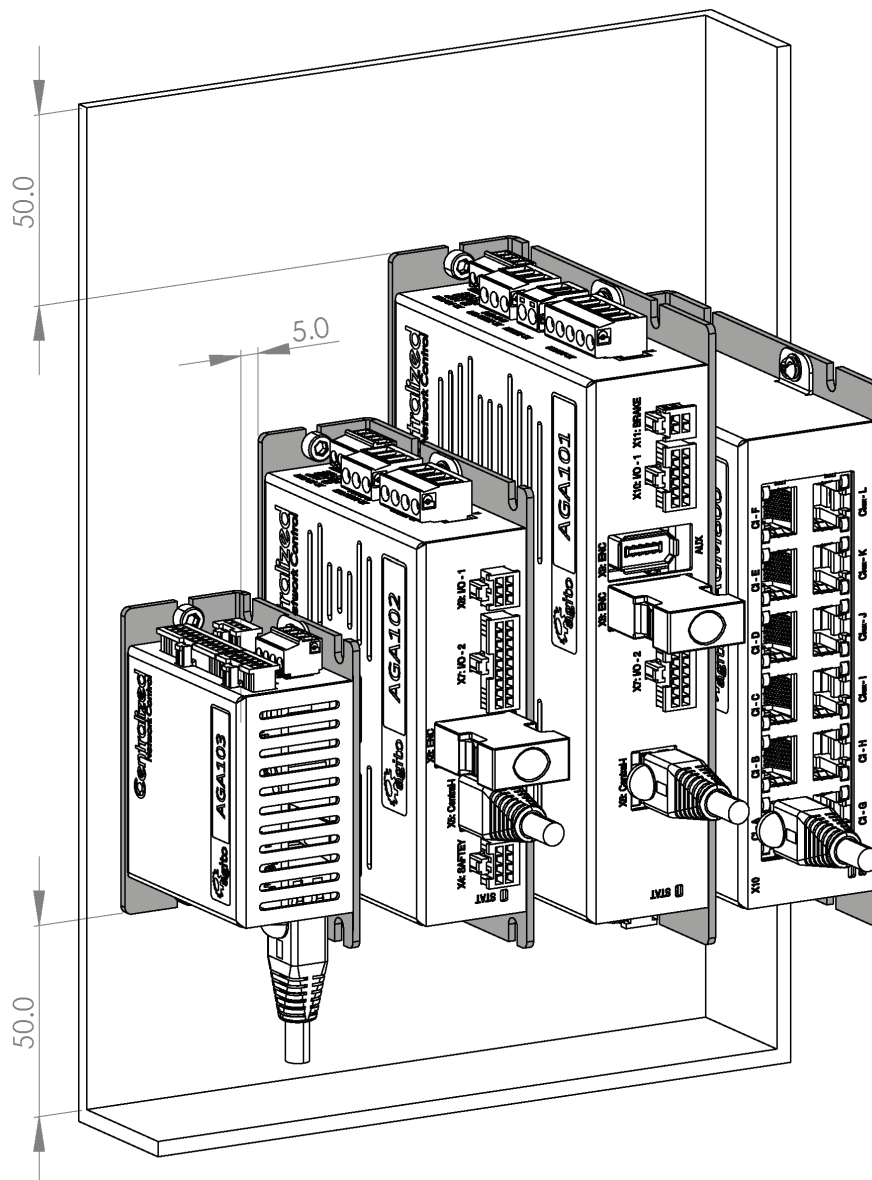


Figure 8. Mounting multiple amplifiers within cabinet - Example

### 3.3 Electrical Installation

#### 3.3.1 Power Supplies

Several power sources are required for AGA10x operation when the amplifier is connected to external devices.

The power sources provide power to the motor and brake, and to logic and I/Os circuits.

| Power Source        | Description                                                                                                       | AGA101        | AGA102    | AGA103    |
|---------------------|-------------------------------------------------------------------------------------------------------------------|---------------|-----------|-----------|
| Main power          | Supplies power to the motor.                                                                                      | 12–90 VDC     | 12–48 VDC | 12–48 VDC |
| Backup power        | Optional. Supplies power to the logic circuits. If not connected, the Main power supply provides the logic power. | 9–36 VDC      | 9–36 VDC  | –         |
| Isolated I/Os power | Optional. Supplies power to the optically isolated I/O circuits.                                                  | 5–36 VDC      | 5–36 VDC  | 5–36 VDC  |
| Brake power         | Optional. Supplies power to the motor brake.                                                                      | 12–48 VDC, 3A | –         | –         |

#### 3.3.2 Wire and Cable Guidelines

To prevent EMI and ensure high performance of the system, be sure to comply with the following guidelines:

- Use twisted pair shielded wires for the control, feedback and communication.
- Always use shielded cables for motor connection.
- Keep all wires and cables as short as possible.
- Keep the motor cables as far as possible from the control, feedback and communication lines and cables.
- Wire impedance must be as low as possible. Refer to the wire gauge definitions for each electrical interface.

#### 3.3.3 Regeneration (AGA101 only)

AGA101 uses the main DC power input to output a controlled electrical power through the phases of the motor. The motor converts this electrical power to a mechanical power that moves the load.

During motor deceleration and stopping, the inertia of the load drives the movement of the motor, not the servo drive. Due to back EMF, the motor acts as a generator and returns energy to the DC bus supply, which causes the DC bus voltage to increase to undesirable level.

Maximum allowable DC bus voltage is 90 VDC. To prevent excessive DC bus voltage, a regeneration resistor can be connected to the AGA101 amplifier's X3 connector to dissipate excess regenerated energy, and prevent it from reaching undesirable levels. The regeneration resistor starts to dissipate energy at 85 VDC.

Regeneration voltage threshold parameters are software configurable and can be modified according to the motor's maximum voltage specification.

**Warning**

DC Vbus is monitored, and motors will be disabled if voltage is too high. However, there is no protection against the connection of an excessive voltage power supply that will damage the product.

For connection details, refer to the section *Interface X3: Regeneration*.

### 3.3.4 Grounding

It is recommended to install the AGA10x on a metal backplane for better power dissipation, reduced EMI, and grounding connection. Make sure the plate is not painted.

The heatsink of the AGA10x is electrically conductive and serves as the protective earth (PE) ground of the product. However, it is critical to ensure the PE screws are electrically conducting between the PE of AGA10x and the PE of the main power supply in the system.

The main power input (Main PWR) connector includes a PE pin. Make sure to connect PE to this pin or to the amplifier's metal heatsink.

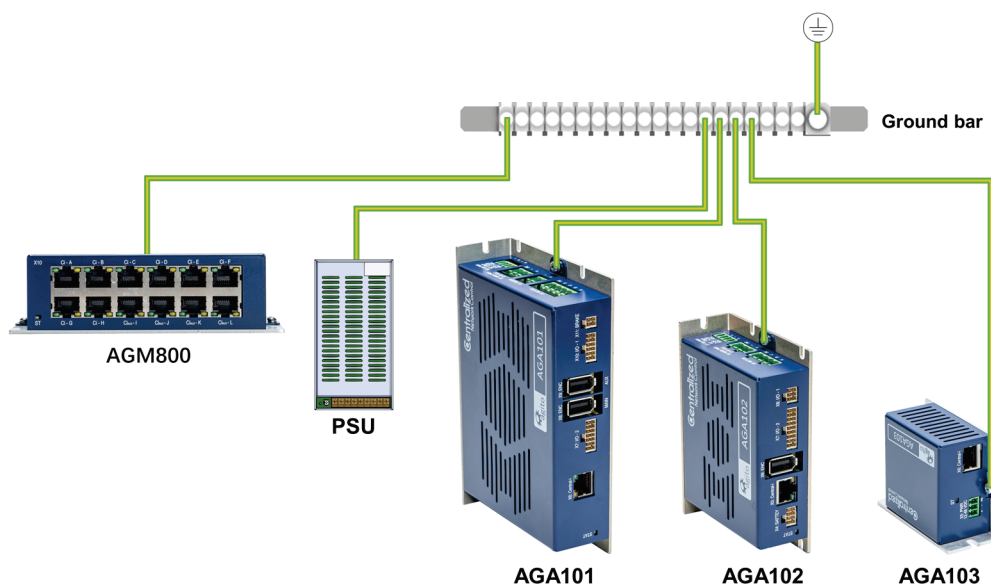


Figure 9. System grounding

### Ground Domains

The following table shows the ground domains in the AGA10x system:

- GND. Reference voltage for digital/analog circuits and signals.
- PGND. High voltage ground domain (internal)
- General. Usually at DC potential close to GND, but not connected internally.

### Ground Domains

| Name                                       | Ground Domain    | Notes                                 |
|--------------------------------------------|------------------|---------------------------------------|
| DC power input                             | GND (I/O return) | External DC power supply              |
| Central-i communication                    | General          | Isolated for Central-i remote devices |
| Isolated digital inputs/outputs            | General          | Isolated                              |
| Differential inputs/outputs (not isolated) | GND              |                                       |
| Analog inputs/outputs (not isolated)       | GND              |                                       |
| Brake control output                       | General          | External DC power supply              |
| Regeneration output                        | PGND             |                                       |

### Grounding Policy

Grounding of the product must comply with the following guidelines:

- The enclosures and other external parts that may be touched by the user are in the safe domain.
- The AGA10x must be connected to protective earth (PE) and connected to the building's ground. PE is protected with an earth-leakage circuit breaker (ELCB); hence it is safe to touch. Refer to Figure 9.
- The power inputs, motor connectors, and regeneration outputs are not safe to touch, and may be exposed if the connector is not populated.
- Digital ground (GND) is assumed to have the same potential (at least in DC) as the PE. That means GND is connected to the PE at some point in the system.
- GND is not connected to PE within the amplifier. The system designer must decide where to connect them. It is recommended to connect PE to GND on the DC power supply.
- PGND is connected directly to mains wires, hence it is just as dangerous as mains to the user.
- All shielded cables, including but not limited to motor, encoders, and power input, have their shield connected to PE as part of the external metal enclosure.
- It is critical to avoid ground loops in the system. A ground loop allows currents to return by two or more different paths, causing electromagnetic interference or even damage to wires.
- The system designer must carefully examine all GND connections in the system to ensure that no loops are created, and that all GND-referenced signals have a GND wire nearby (for both return currents and common mode voltage).

### 3.4 Communication – Central-i

The AGA10x amplifiers use Central-i for communication with a centralized controller module.

The Central-i motion control platform includes a multi-axis motion controller, distributed amplifiers and sensors, and control software. The master controller performs all the control functions, including trajectory and position, velocity, and current loops. The Central-i digital protocol enables communication and synchronization of the remote devices.

A bi-colored LED, marked **STAT** on AGA101 and AGA102, and **ST** on AGA103 shows the status of communication between the amplifier and the Central-i master controller.

#### Central-i Status LED indicator

| Color | LED       | Meaning                                            |
|-------|-----------|----------------------------------------------------|
| Green | On steady | Amplifier communicating with master controller     |
| Red   | On steady | Amplifier not communicating with master controller |

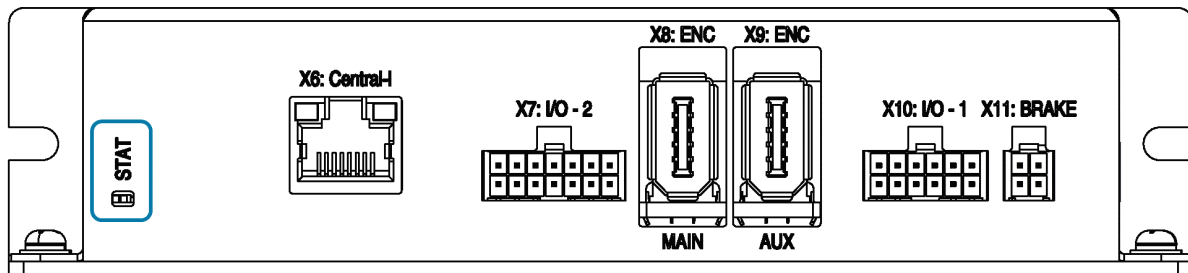


Figure 10. Status (LED) indicator (AGA101)

## 3.5 AGA101 – Electrical Interfaces

### 3.5.1 Interface X2: Main Power

Connector X2 is used to supply 12–90 VDC to the AGA101.

The amplifier includes protection to prevent damage if polarity is inverted at the power input.



#### Note – Optional scheme for isolated power supplies

The amplifier can support fully isolated power supplies, one for the power circuitry to drive the motor, and one for the digital logic. If you are interested in such a scheme, contact Technical Support.

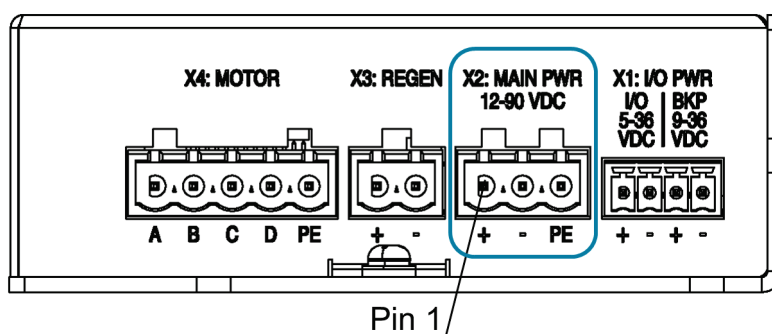


Figure 11. Power connector

#### Connector X2: MAIN PWR

| Pin # | Name       | Description                              |
|-------|------------|------------------------------------------|
| 1     | Main power | Power input: 12–90V, up to 8A continuous |
| 2     | Power GND  | Ground – power return                    |
| 3     | GND-EARTH  | Protective earth                         |

|                              |                                      |
|------------------------------|--------------------------------------|
| Connector manufacturer       | DEGSON (Phoenix compatible)          |
| Mating connector part number | 1757022                              |
| Connector pitch              | 5.08 mm                              |
| Wiring                       | 12–24 AWG, insulation rated for 250V |

### 3.5.2 Interface X5: Safety

Connector X5 is used for the hardware safety function that disables power to the motor.

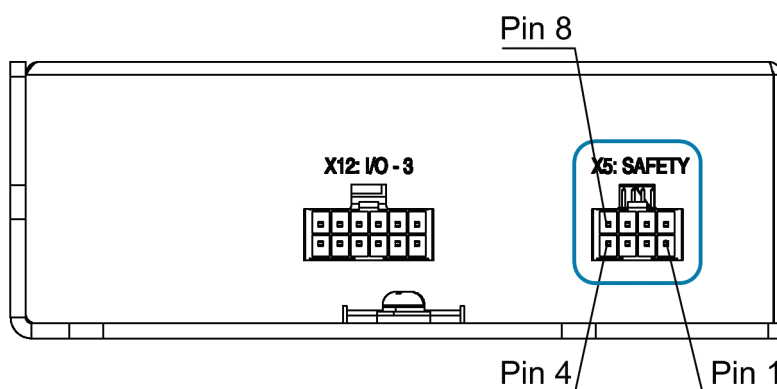


Figure 12. Safety connector

#### Connector X5: SAFETY

| Pin # | Name             | Description                                 |
|-------|------------------|---------------------------------------------|
| 1     | 5V               | 5V supply for safety circuits               |
| 2     | Safety_Feedback- | Safety_Feedback negative (emitter) output   |
| 3     | Safety_Input_2-  | Safety_Input_2 negative input               |
| 4     | Safety_Input_1-  | Safety_Input_1 negative input               |
| 5     | GND              | Ground                                      |
| 6     | Safety_feedback+ | Safety_Feedback positive (collector) output |
| 7     | Safety_Input_2+  | Safety_Input_2 positive input               |
| 8     | Safety_Input_1+  | Safety_Input_1 positive input               |

|                              |                                   |
|------------------------------|-----------------------------------|
| Connector manufacturer       | Samtec Inc.                       |
| Mating connector part number | IPD1-04-D-K                       |
| Crimp part number            | CC79L-2630-01-L (or equivalent)   |
| Wiring                       | 26 AWG, insulation rated for 100V |



#### Note – Safety Bypass

To bypass the safety circuit on the AGA101, do the following on connector X5:

- Connect pin 1 to both pin 7 and pin 8.
- Connect pin 5 to both pin 3 and pin 4.

### Safety connector circuit diagram

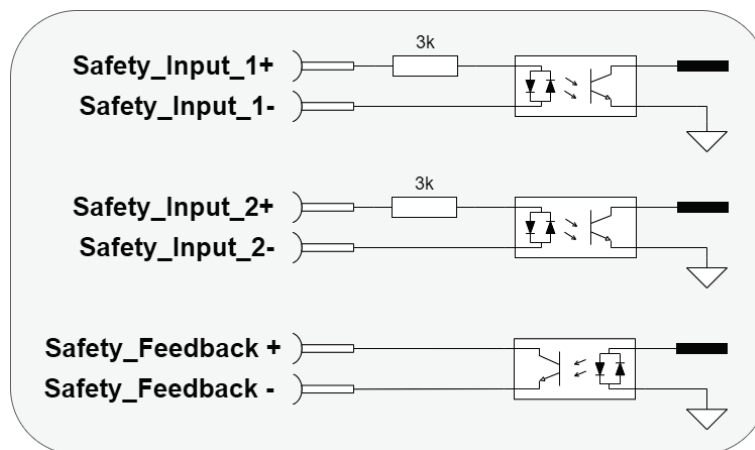


Figure 13. Electrical interfaces – safety connector

- Safety\_Input\_1 and Safety\_Input\_2 function independently, thus providing safety redundancy. Each one can disable the power to the motor.
- Both Safety\_Input\_1 and Safety\_Input\_2 disable the power to the motor through hardware circuitry, without any software intervention.
- Both Safety\_Input\_1 and Safety\_Input\_2 are defined with a positive pin (+) and a negative pin (-). However, the opto-coupler at the Safety\_Input has two input diodes, which enable operation at "positive" or "negative" input voltage. The input is activated when current is sufficient at one of the input diodes, regardless of the current direction. This enables NPN or PNP connection to the safety inputs.
- The Safety\_Input protection logic is designed so that both Safety\_Inputs must be powered to enable motor operation. Leaving a Safety\_Input disconnected prevents motor operation. This logic is required to ensure that a disconnected safety cable is considered an unsafe condition by the control unit. When sufficient current is driven through a Safety\_Input, the state of this input is Safe. When insufficient current is driven through a Safety\_Input, the state of this input is Unsafe.
- The two Safety\_Inputs must be in the Safe state to enable motor operation.
- Both Safety\_Input\_1 and Safety\_Input\_2, although acting on the drive hardware directly, are also monitored by the controller software. The controller software generates a feedback signal to the user (Safety\_Feedback), which is also an isolated signal. This feedback is generated by the software, and is activated if at least one of Safety\_Input\_1 or Safety\_Input\_2 signals is in the Unsafe state.
- The electrical characteristics of the Safety\_Input\_1 and Safety\_Input\_2 are identical to those of all other isolated digital inputs of the controller.
- The safety inputs implemented in the product are currently pending certification Functional Safety Standards.

### 3.5.3 Interface X1: I/O and Backup Power

Connector X1 has two functions. It supplies DC power supply to the isolated I/Os. Optionally, it provides backup power for the logic components.

The amplifier includes protection to prevent damage if polarity is inverted at the power input.

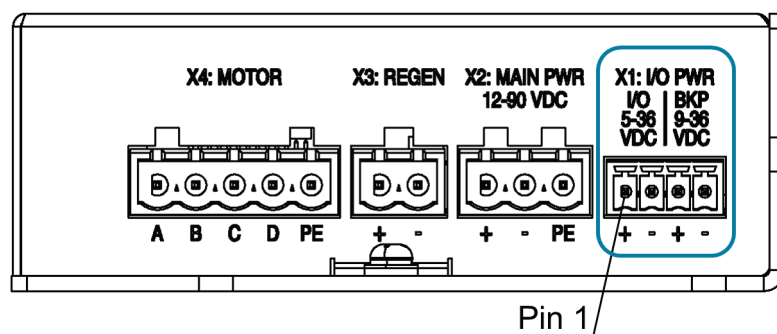


Figure 14. I/O and backup power connector

#### Connector X1: I/O PWR

| Pin # | Name                      | Description                                        |
|-------|---------------------------|----------------------------------------------------|
| 1     | Isolated I/O power        | 5–36 VDC – user supplied I/O power input, up to 2A |
| 2     | Isolated I/O power return | Ground – I/O power return                          |
| 3     | Backup/logic power        | 9–36 VDC – backup/logic power, up to 50W           |
| 4     | Backup power GND          | Ground – backup/logic power return                 |

|                              |                                      |
|------------------------------|--------------------------------------|
| Connector manufacturer       | DEGSON (Phoenix compatible)          |
| Mating connector part number | 1840382                              |
| Connector pitch              | 3.5 mm                               |
| Wiring                       | 16–28 AWG, insulation rated for 160V |



#### Warning - Hot plugging is forbidden!

Plug or unplug the power connector only when power is off! Plugging the power connector when power is on may cause power surges through connected devices and possibly damage them.

### 3.5.4 Interface X4: Motor

Connector X4 serves to supply power to the motor, which can be a 3-phase brushless motor, a single phase brushed motor or a voice coil motor, or a stepper motor.

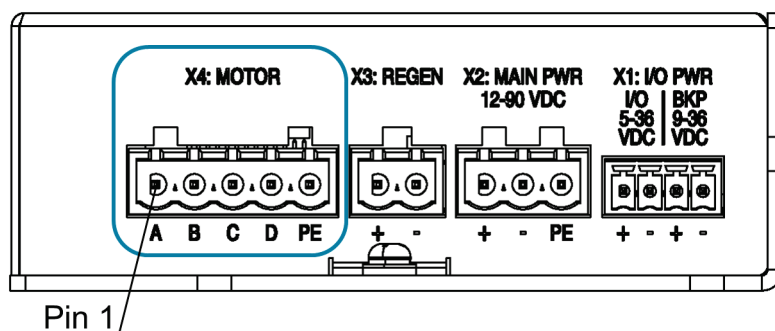


Figure 15. Motor connector

#### Connector X4: MOTOR

| Pin # | Label | Brushless Motor               | Brushed or Voice Coil Motor   | Stepper Motor                              |
|-------|-------|-------------------------------|-------------------------------|--------------------------------------------|
| 1     | A     | Motor phase A                 | Motor phase +                 | Motor phase 1+                             |
| 2     | B     | Motor phase B                 | Motor phase -                 | Motor phase 2+                             |
| 3     | C     | Motor phase C                 | Not connected                 | Motor phases 1- and 2-<br>(see Note below) |
| 4     | D     | Not connected                 | Not connected                 | Not connected                              |
| 5     | PE    | GND_EARTH<br>Protective earth | GND_EARTH<br>Protective earth | GND_EARTH<br>Protective earth              |

|                              |                                      |
|------------------------------|--------------------------------------|
| Connector manufacturer       | DEGSON (Phoenix compatible)          |
| Mating connector part number | 1757048                              |
| Connector pitch              | 5.08 mm                              |
| Wiring                       | 12–24 AWG, insulation rated for 250V |



#### Note – Stepper voltage range

A bipolar stepper motor has two independent phases (4 wires in total). For the AGA101, you must connect the (-) wire of both phases to pin 3 on connector X4.

This connection implies a limitation of the voltage that will be applied to the stepper.

For example, if the power supply to the unit is 24V, each phase of the stepper motor will be limited to 12V.

With suitable selection of the power supply this should impose no limitation on the stepper motor operation.

### 3.5.5 Interface X3: Regeneration

Connector X3 is used to connect an external power resistor to dissipate energy generated by the motor, typically during deceleration. The motor-generated energy will charge up the internal capacitor. When the internal capacitor is fully charged, the bus voltage will increase. When bus voltage is higher than the operating limit of the product, it will trigger over-voltage protection and disable the motor. To prevent this from happening, users can connect an external power resistor to dissipate the unwanted energy.

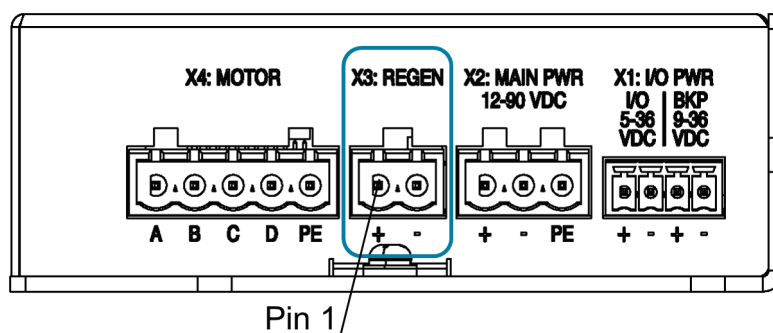


Figure 16. Regeneration connector

#### Connector X3: REGEN

| Pin # | Name            | Description                                                                                                                                                           |
|-------|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1     | Internal DC bus | The internal DC bus power                                                                                                                                             |
| 2     | Regeneration    | To be connected to an external regeneration resistor. Limited to 16A.<br>The external regeneration resistor must be connected between pins 1 and 2 of this connector. |

|                              |                                      |
|------------------------------|--------------------------------------|
| Connector manufacturer       | DEGSON (Phoenix compatible)          |
| Mating connector part number | 1757019                              |
| Connector pitch              | 5.08 mm                              |
| Wiring                       | 12–24 AWG, insulation rated for 250V |

### 3.5.6 Interface X11: Brake

Some motors may have a static brake, which is engaged when the motor is not enabled. Connector X11 is used this functionality.

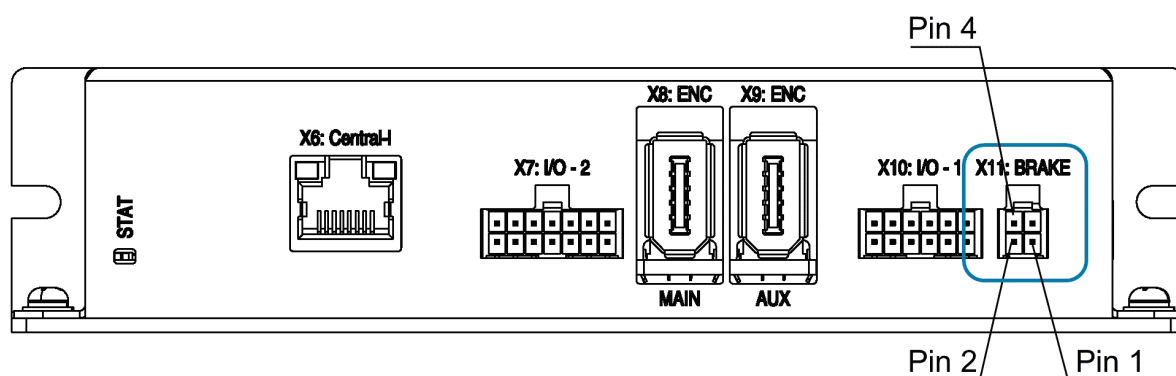


Figure 17. Brake connector

#### Connector X11: BRAKE

| Pin # | Name               | Description                                                                                                                                                    |
|-------|--------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1     | Static_Brake_High  | Static brake output for motor. Open-drain output with built-in flyback diode to the Brake_Power for direct connection into inductive load. Up to 3A operation. |
| 2     | Brake_Power        | Power supply for the brake isolated circuits. Up to 48 VDC.                                                                                                    |
| 3     | Brake_Power_RTN    | Return for Brake_Power                                                                                                                                         |
| 4     | NC (not connected) | Not used                                                                                                                                                       |

|                              |                                   |
|------------------------------|-----------------------------------|
| Connector manufacturer       | Samtec Inc.                       |
| Mating connector part number | IPD1-02-D-K                       |
| Crimp part number            | CC79L-2630-01-L                   |
| Wiring                       | 26 AWG, insulation rated for 100V |

#### Static brake connector circuit diagram

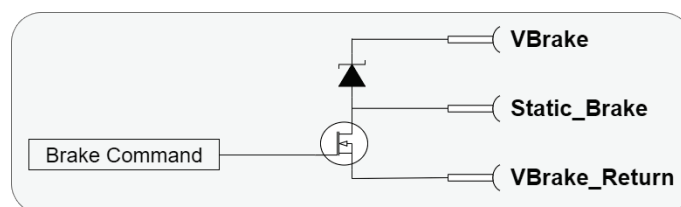


Figure 18. Electrical interfaces – static brake

### 3.5.7 Interfaces X8 and X9: Encoders

X8 and X9 are identical connectors. Each one serves as an interface to a single encoder.

Typically, X8 is used for the motor encoder. X9 is used for the secondary feedback device in a dual-loop control system.

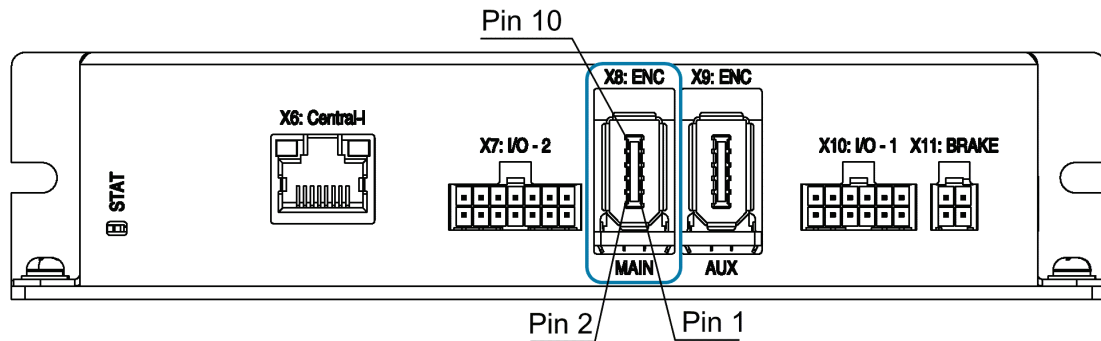


Figure 19. Main encoder connector

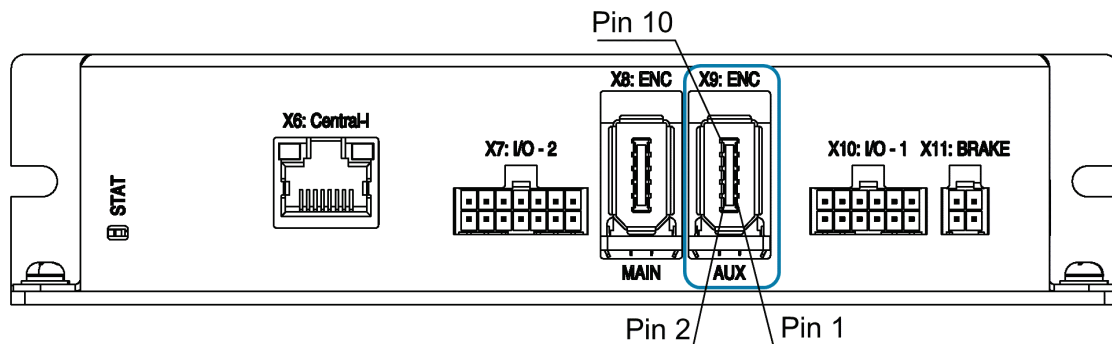


Figure 20. Auxiliary encoder connector

#### Connectors X8/X9: ENC

| Pin # | Name       | Encoder Types |         |        |           | Description                                                                |
|-------|------------|---------------|---------|--------|-----------|----------------------------------------------------------------------------|
|       |            | AqB           | Sin/Cos | BiSS-C | EnDat 2.2 |                                                                            |
| 1     | 5V         |               |         |        |           | 5V power supply (limited to 0.5A per connector)                            |
| 2     | GND        |               |         |        |           | 5V return and reference for differential signals                           |
| 3     | Encoder_1+ |               |         | Clock+ | Clock+    | Clock+ pin for absolute encoders                                           |
| 4     | Encoder_1- |               |         | Clock- | Clock-    | Clock- pin for absolute encoders                                           |
| 5     | Encoder_2+ | A+            | Sin+    |        |           | A+ (for AqB) or sin+ (for analog sin/cos)                                  |
| 6     | Encoder_2- | A-            | Sin-    |        |           | A- (for AqB) or sin- (for analog sin/cos)                                  |
| 7     | Encoder_3+ | B+            | Cos+    |        |           | B+ (for AqB) or cos+ (for analog sin/cos)                                  |
| 8     | Encoder_3- | B-            | Cos-    |        |           | B- (for AqB) or cos- (for analog sin/cos)                                  |
| 9     | Encoder_4+ | Z+            | Z+      | Data+  | Data+     | Data+ for absolute encoders, or Z+ for both AqB and analog sin/cos encoder |
| 10    | Encoder_4- | Z-            | Z-      | Data-  | Data-     | Data- for absolute encoders, or Z- for both AqB and analog sin/cos encoder |

|                              |                                   |
|------------------------------|-----------------------------------|
| Connector manufacturer       | SUNCHU                            |
| Mating connector part number | SC-10-4P                          |
| Wiring                       | 26 AWG, insulation rated for 100V |



#### Note – Incremental encoder interface

---

Each differential-pair includes a built-in 120Ω terminator and the required hardware circuits to detect a disconnected encoder cable. When a disconnected encoder cable is detected, the controller will disable the motor. The detection is done on the A and B channels only (not on the index/Z-channel).

By default, the product does not support single-ended encoder. For use of single-ended encoder, contact Technical Support.



#### Note – 5V supply limitation

---

The 5V supply provided at pin 1 on each connector (X8 and X9) is limited to 0.5A per connector.

The maximum total current provided by all the 5V pins in the product is limited to 1.5A.

### 3.5.8 Interfaces X7, X10 and X12: I/Os

Connectors X7, X10 and X12 are used for connecting external I/O devices to the amplifier.

For schematics and more information about these interfaces, refer to the section Electrical Interfaces Circuit Diagrams.

#### Interface X7

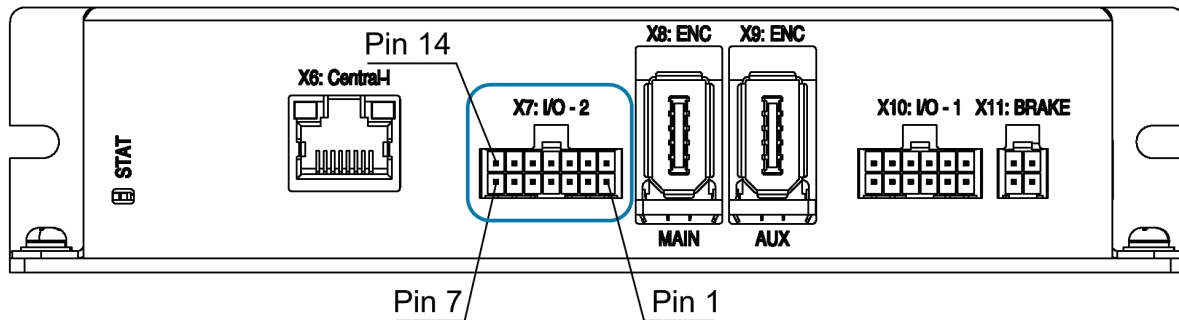


Figure 21. I/O-2 connector

#### Connector X7: I/O-2

| Pin # | Name                                  | Software Representation            | Description                                                                                                                                                                             |
|-------|---------------------------------------|------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1     | Vin_24V_IO_RTN                        |                                    | I/O power return                                                                                                                                                                        |
| 2     | Vin_24V_IO                            |                                    | 24V I/O power                                                                                                                                                                           |
| 3     | Digital_Output_1                      | DOutPort.bit(0)                    | Isolated digital input 1. Programmable sink or source.                                                                                                                                  |
| 4     | Digital_Output_Common_Power (1 to 3)  |                                    | Common power pin for isolated digital outputs 1 to 3.                                                                                                                                   |
| 5     | Digital_Input_6                       | DInPort.bit(5)                     | Isolated digital input 6 (NPN or PNP, depending on the connection of the group's common pin).                                                                                           |
| 6     | Digital_Input_Common_Power (5 to 7)   |                                    | Common power pin for isolated digital inputs 5 to 7.                                                                                                                                    |
| 7     | Bi-Dir_Diff_IO_1+                     | DInPort.bit(11)<br>DOutPort.bit(3) | Bi-directional differential I/O 1- Software configurable: <ul style="list-style-type: none"> <li>BiDirConfig.bit(0) = 0 for input</li> <li>BiDirConfig.bit(0) = 1 for output</li> </ul> |
| 8     | GND_EARTH                             |                                    | Protective earth connection                                                                                                                                                             |
| 9     | Digital_Output_3                      | DOutPort.bit(2)                    | Isolated digital input 3. Programmable sink or source.                                                                                                                                  |
| 10    | Digital_Output_2                      | DOutPort.bit(1)                    | Isolated digital input 2. Programmable sink or source.                                                                                                                                  |
| 11    | Digital_Output_Common_Return (1 to 3) |                                    | Common power return pin for isolated digital outputs 1 to 3.                                                                                                                            |

| Pin # | Name              | Software Representation            | Description                                                                                                                                                                                |
|-------|-------------------|------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 12    | Digital_Input_7   | DInPort.bit(6)                     | Isolated digital input 7 (NPN or PNP, depending on the connection of the group's common pin).                                                                                              |
| 13    | Digital_Input_5   | DInPort.bit(4)                     | Isolated digital input 5 (NPN or PNP, depending on the connection of the group's common pin).                                                                                              |
| 14    | Bi-Dir_Diff_IO_1- | DInPort.bit(11)<br>DOutPort.bit(3) | Bi-directional differential I/O 1-<br>Software configurable: <ul style="list-style-type: none"> <li>BiDirConfig.bit(0) = 0 for input</li> <li>BiDirConfig.bit(0) = 1 for output</li> </ul> |

|                              |                                   |
|------------------------------|-----------------------------------|
| Connector manufacturer       | Samtec Inc                        |
| Mating connector part number | IPD1-06-D-K                       |
| Crimp part number            | CC79L-2630-01-L                   |
| Wiring                       | 26 AWG, insulation rated for 100V |

## Interface X10

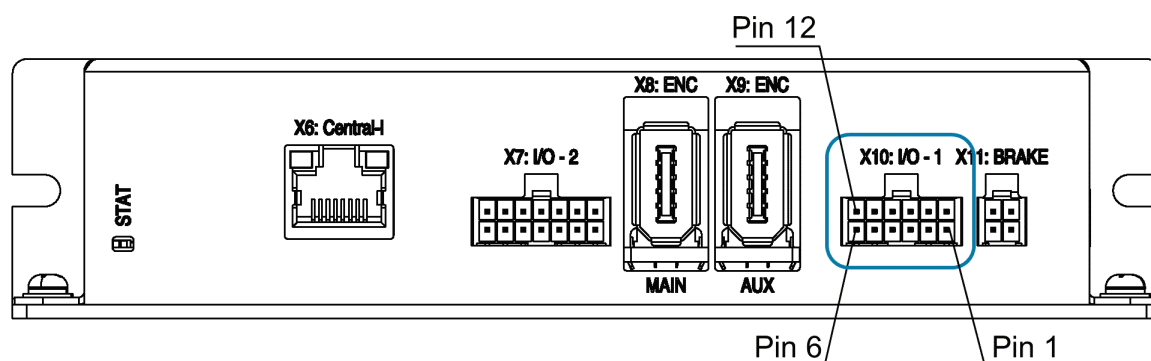


Figure 22. I/O-1 connector

## Connector: X10: I/O-1

| Pin # | Name                          | Software Representation | Description                                                                                   |
|-------|-------------------------------|-------------------------|-----------------------------------------------------------------------------------------------|
| 1     | Vin_24V_IO_RTN                |                         | I/O power return                                                                              |
| 2     | Vin_24V_IO                    |                         | 24V I/O power                                                                                 |
| 3     | Digital_Input_4               | DInPort.bit(3)          | Isolated digital input 4 (NPN or PNP, depending on the connection of the group's common pin). |
| 4     | Digital_Input_2               | DInPort.bit(1)          | Isolated digital input 2 (NPN or PNP, depending on the connection of the group's common pin). |
| 5     | Digital Input_Common (1 to 4) |                         | Common power pin for isolated digital inputs 1 to 4.                                          |
| 6     | Analog_Input_1                | AIInPort[1]             | Analog input 1, $\pm 12V$ , 12 bit                                                            |
| 7     | GND_EARTH                     |                         | Protective earth                                                                              |
| 8     | GND                           |                         | Ground                                                                                        |
| 9     | 5V                            |                         | 5V power supply for other components                                                          |
| 10    | Digital_Input_3               | DInPort.bit(2)          | Isolated digital input 3 (NPN or PNP, depending on the connection of the group's common pin). |
| 11    | Digital_Input_1               | DInPort.bit(0)          | Isolated digital input 1 (NPN or PNP, depending on the connection of the group's common pin). |
| 12    | Digital_Input_4               |                         | Analog input 1 return.<br>Not connected internally to GND.                                    |

|                              |                                   |
|------------------------------|-----------------------------------|
| Connector manufacturer       | Samtec Inc                        |
| Mating connector part number | IPD1-06-D-K                       |
| Crimp part number            | CC79L-2630-01-L                   |
| Wiring                       | 26 AWG, insulation rated for 100V |

**Note – 5V supply limitation**

The 5V supply provided at pin 9 on connectors X10 and X12 is limited to 0.5A (for both pins together).

The maximum total current provided by all the 5V pins in the product is limited to 1.5A.

## Interface X12

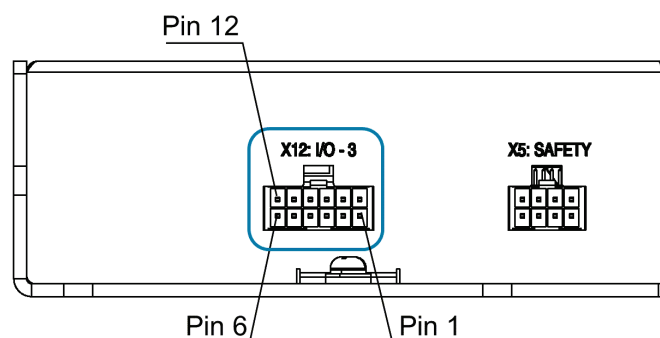


Figure 23. I/O-3 connector

## Connector X12: I/O-3

| Pin # | Name                           | Software Representation | Description                                                                                   |
|-------|--------------------------------|-------------------------|-----------------------------------------------------------------------------------------------|
| 1     | Vin_24V_IO_RTN                 |                         | I/O power return                                                                              |
| 2     | Vin_24V_IO                     |                         | 24V I/O power                                                                                 |
| 3     | Digital_Input_11               | DInPort.bit(10)         | Isolated digital input 11 (NPN or PNP, depending on the connection of the group's common pin) |
| 4     | Digital_Input_9                | DInPort.bit(8)          | Isolated digital input 9 (NPN or PNP, depending on the connection of the group's common pin)  |
| 5     | Digital_Input_Common (8 to 11) |                         | Common power pin for isolated digital inputs 8 to 11.                                         |
| 6     | Analog_Input_2                 | AInPort[2]              | Analog input 2, $\pm 12V$ , 12-bit                                                            |
| 7     | GND_EARTH                      |                         | Protective earth                                                                              |
| 8     | GND                            |                         | Ground                                                                                        |
| 9     | 5V                             |                         | 5V power supply for other components                                                          |
| 10    | Digital_Input_10               | DInPort.bit(9)          | Isolated digital input 10 (NPN or PNP, depending on the connection of the group's common pin) |
| 11    | Digital_Input_8                | DInPort.bit(7)          | Isolated digital input 8 (NPN or PNP, depending on the connection of the group's common pin)  |
| 12    | Analog_Input_Return_2          |                         | Analog input 2 return.<br>Not connected internally to GND.                                    |

|                              |                                   |
|------------------------------|-----------------------------------|
| Connector manufacturer       | Samtec Inc                        |
| Mating connector part number | IPD1-06-D-K                       |
| Crimp part number            | CC79L-2630-01-L                   |
| Wiring                       | 26 AWG, insulation rated for 100V |



## Note – 5V supply limitation

The 5V supply provided at pin 9 on connectors X10 and X12 is limited to 0.5A (for both pins together).

The maximum total current provided by all the 5V pins in the product is limited to 1.5A.

### 3.5.9 Interface X6: Central-i

Connector X5 is used for communication with the Central-i master controller, such as the AGM800, and other remote amplifiers and devices.

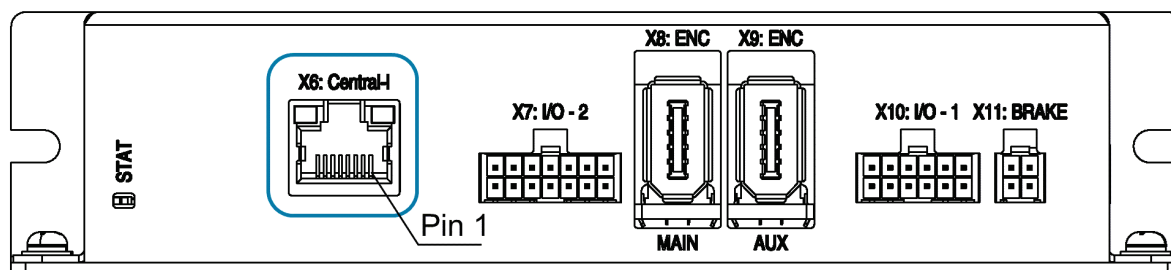


Figure 24. Communication connector (Central-i)

#### Connector X6: Central-i (RJ45)

| Pin # | Name                    | Description             |
|-------|-------------------------|-------------------------|
| 1     | Central-i data0+        | Bi-directional + data + |
| 2     | Central-i data0-        | Data -                  |
| 3     | Central-i data1+        | Data +                  |
| 4     | Central-i data2-        | Bi-directional +        |
| 5     | BI-_D3 Central-i data2+ | Bi-directional +        |
| 6     | RX-_D2 Central-i data1- | Receive data -          |
| 7     | BI+_D45V_CI             | Bi-directional +        |
| 8     | BI-_D4CI_GND            | Bi-directional -        |

|                              |                                                   |
|------------------------------|---------------------------------------------------|
| Connector type               | RJ45 LAN 10/100Base-T connector                   |
| Mating connector part number | Any CAT5e compatible shielded connector           |
| Cable                        | CAT5e or higher, standard Ethernet straight cable |

## 3.6 AGA102 – Electrical Interfaces

### 3.6.1 Interface X2: Main Power

Connector X2 is used to supply 12–48 VDC to the AGA102. The input voltage is connected directly to the amplifier power bridge to drive the axis motor. The input voltage also supplies the power for the amplifier internal logic.

The amplifier includes protection to prevent damage if polarity is inverted at the power input.



#### Note – Optional scheme for isolated power supplies

The amplifier can support fully isolated power supplies, one for the power circuitry to drive the motor, and one for the digital logic. If you are interested in such a scheme, contact Technical Support.

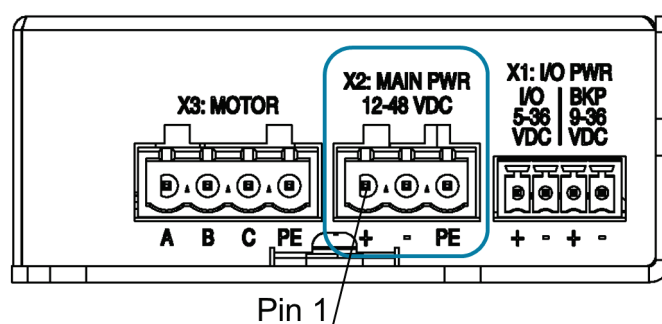


Figure 25. Power connector

#### Connector J2: Power

| Pin # | Name       | Description                              |
|-------|------------|------------------------------------------|
| 1     | Main Power | Power input: 12–48V, up to 8A continuous |
| 2     | Power GND  | Power GND                                |
| 3     | GND-EARTH  | Earth ground connection                  |

|                              |                                      |
|------------------------------|--------------------------------------|
| Connector manufacturer       | DEGSON (Phoenix compatible)          |
| Mating connector part number | MSTB 2,5/ 3-ST-5,08                  |
| Crimp part number            | 1757022                              |
| Connector pitch              | 5.08 mm                              |
| Wiring                       | 12–24 AWG, insulation rated for 250V |

### 3.6.2 Interface X4: Safety

Connector X4 is used for the hardware safety function that disables power to the motor.

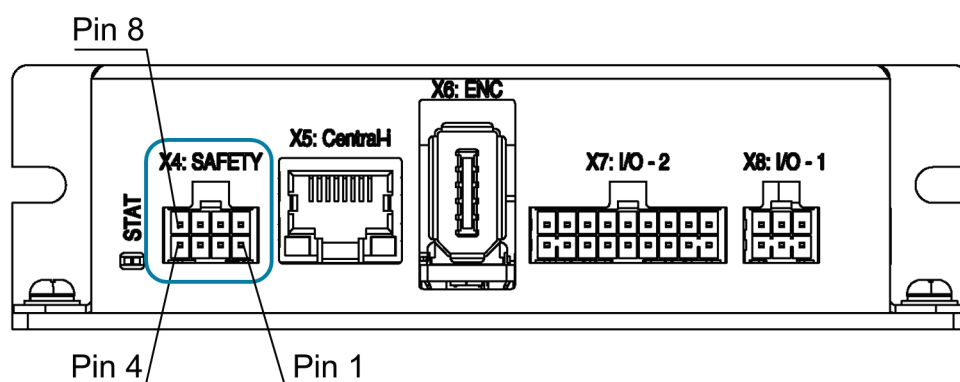


Figure 26. Safety connector

#### Connector X4: SAFETY

| Pin # | Name             | Description                                 |
|-------|------------------|---------------------------------------------|
| 1     | 5V               | 5V supply for safety circuits               |
| 2     | Safety_feedback- | Safety_feedback negative (emitter) output   |
| 3     | Safety_input_2-  | Safety_input_2 negative input               |
| 4     | Safety_input_1-  | Safety_input_1 negative input               |
| 5     | GND              | Ground                                      |
| 6     | Safety_feedback+ | Safety_feedback positive (collector) output |
| 7     | Safety_input_2+  | Safety_input_2 positive input               |
| 8     | Safety_input_1+  | Safety_input_1 positive input               |

|                              |                                   |
|------------------------------|-----------------------------------|
| Connector manufacturer       | Samtec Inc.                       |
| Mating connector part number | IPD1-04-D-K                       |
| Crimp part number            | CC79L-2630-01-L (or equivalent)   |
| Wiring                       | 26 AWG, insulation rated for 100V |

### Safety connector circuit diagram

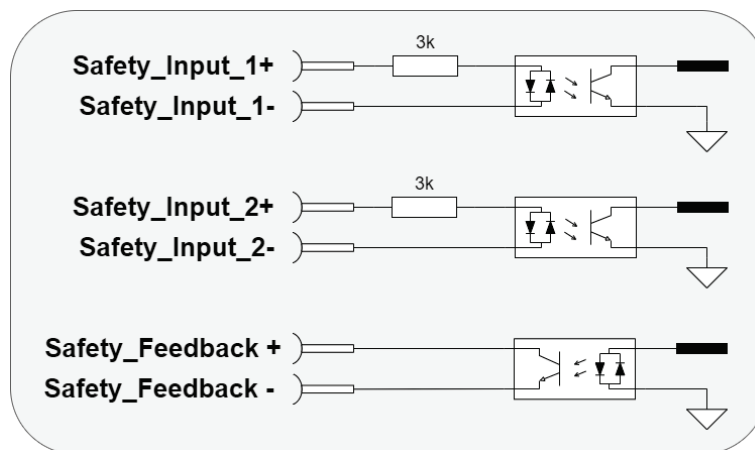


Figure 27. Electrical interfaces – safety connector

- Safety\_Input\_1 and Safety\_Input\_2 function independently, thus providing safety redundancy. Each one can disable the power to the motor.
- Both Safety\_Input\_1 and Safety\_Input\_2 disable the power to the motor through hardware circuitry, without any software intervention.
- Both Safety\_Input\_1 and Safety\_Input\_2 are defined with a positive pin (+) and a negative pin (-). However, the opto-coupler at the Safety\_Input has two input diodes, which enable operation at "positive" or "negative" input voltage. The input is activated when current is sufficient at one of the input diodes, regardless of the current direction. This enables NPN or PNP connection to the safety inputs.
- The Safety\_Input protection logic is designed so that both Safety\_Inputs must be powered to enable motor operation. Leaving a Safety\_Input disconnected prevents motor operation. This logic is required to ensure that a disconnected safety cable is considered an unsafe condition by the control unit. When sufficient current is driven through a Safety\_Input, the state of this input is Safe. When insufficient current is driven through a Safety\_Input, the state of this input is Unsafe.
- The two Safety\_Inputs must be in the Safe state to enable motor operation.
- Both Safety\_Input\_1 and Safety\_Input\_2, although acting on the drive hardware directly, are also monitored by the controller software. The controller software generates a feedback signal to the user (Safety\_Feedback), which is also an isolated signal. This feedback is generated by the software, and is activated if at least one of Safety\_Input\_1 or Safety\_Input\_2 signals is in the Unsafe state.
- The electrical characteristics of the Safety\_Input\_1 and Safety\_Input\_2 are identical to those of all other isolated digital inputs of the controller.
- The safety inputs implemented in the product are currently pending certification Functional Safety Standards.

### 3.6.3 Interface X1: I/O and Backup Power

Connector X1 has two functions. It supplies DC power supply to the isolated I/Os. Optionally, it provides backup power for the logic components.

The amplifier includes protection to prevent damage if polarity is inverted at the power input.

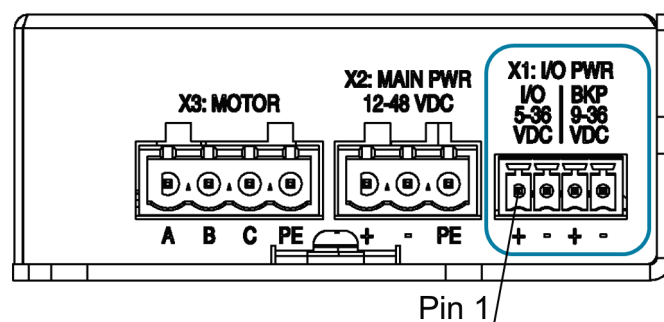


Figure 28. I/O and backup power connector

#### Connector X1: I/O PWR

| Pin # | Name                      | Description                                        |
|-------|---------------------------|----------------------------------------------------|
| 1     | Isolated I/O power        | 5–36 VDC – user supplied I/O power input, up to 2A |
| 2     | Isolated I/O power return | Ground – I/O power return                          |
| 3     | Backup/logic power        | 9–36 VDC – backup/logic power, up to 50W           |
| 4     | Backup power GND          | Ground – backup/logic power return                 |

|                              |                                      |
|------------------------------|--------------------------------------|
| Connector manufacturer       | DEGSON (Phoenix compatible)          |
| Mating connector part number | 1840382                              |
| Connector pitch              | 3.5 mm                               |
| Wiring                       | 16–28 AWG, insulation rated for 160V |



#### Warning - Hot plugging is forbidden!

Plug or unplug the power connector only when power is off! Plugging the power connector when power is on may cause power surges through connected devices and possibly damage them.

### 3.6.4 Interface X3: Motor

Connector X3 serves to supply power to the motor, which can be a 3-phase brushless motor, a single phase brushed motor, a voice coil motor, or a stepper motor.

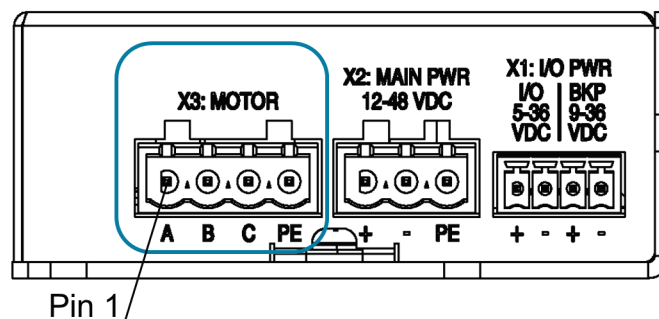


Figure 29. Motor connector

#### Connector X4: MOTOR

| Pin # | Label | Brushless Motor               | Brushed or Voice Coil Motor   | Stepper Motor                              |
|-------|-------|-------------------------------|-------------------------------|--------------------------------------------|
| 1     | A     | Motor phase A                 | Motor phase +                 | Motor phase 1+                             |
| 2     | B     | Motor phase B                 | Motor phase -                 | Motor phase 2+                             |
| 3     | C     | Motor phase C                 | Not connected                 | Motor phases 1- and 2-<br>(see Note below) |
| 4     | PE    | GND_EARTH<br>Protective earth | GND_EARTH<br>Protective earth | GND_EARTH<br>Protective earth              |

|                              |                                        |
|------------------------------|----------------------------------------|
| Connector manufacturer       | DEGSON (Phoenix compatible)            |
| Mating connector part number | 1757035                                |
| Connector pitch              | 5.08 mm                                |
| Wiring                       | 12 - 24 AWG, insulation rated for 250V |



#### Note – Stepper voltage range

A bipolar stepper motor has two independent phases (4 wires in total). For the AGA102, you must connect the (-) wire of both phases together, to pin 3 on connector X3.

This connection implies a limitation of the voltage that will be applied to the stepper.

For example, if the power supply to the unit is 24V, each phase of the stepper motor will be limited to 12V.

With suitable selection of the power supply this should impose no limitation on the stepper motor operation.

### 3.6.5 Interface X6: Encoder

Connector X6 serves as an interface to a single encoder.

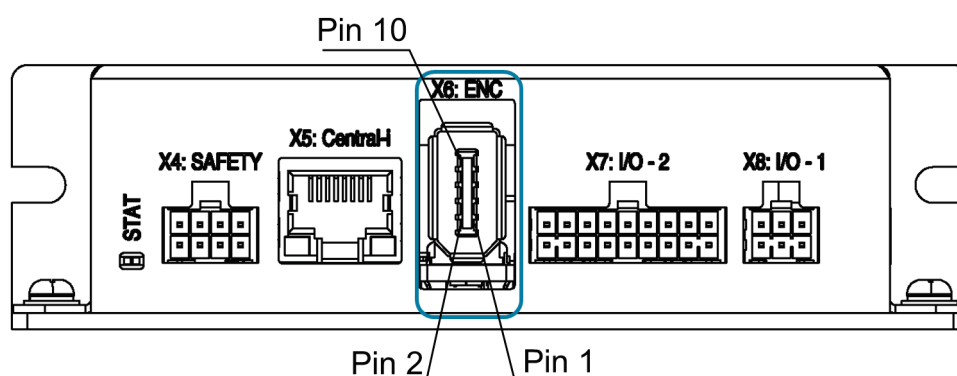


Figure 30. Encoder connector

#### Connectors X6: ENC

| Pin # | Name       | Encoder Types |         |        |           | Description                                                                |
|-------|------------|---------------|---------|--------|-----------|----------------------------------------------------------------------------|
|       |            | AqB           | Sin/Cos | BiSS-C | EnDat 2.2 |                                                                            |
| 1     | 5V         |               |         |        |           | 5V power supply (limited to 0.5A per connector)                            |
| 2     | GND        |               |         |        |           | 5V return and reference for differential signals                           |
| 3     | Encoder_1+ |               |         | Clock+ | Clock+    | Clock+ pin for absolute encoders                                           |
| 4     | Encoder_1- |               |         | Clock- | Clock-    | Clock- pin for absolute encoders                                           |
| 5     | Encoder_2+ | A+            | Sin+    |        |           | A+ (for AqB) or sin+ (for analog sin/cos)                                  |
| 6     | Encoder_2- | A-            | Sin-    |        |           | A- (for AqB) or sin- (for analog sin/cos)                                  |
| 7     | Encoder_3+ | B+            | Cos+    |        |           | B+ (for AqB) or cos+ (for analog sin/cos)                                  |
| 8     | Encoder_3- | B-            | Cos-    |        |           | B- (for AqB) or cos- (for analog sin/cos)                                  |
| 9     | Encoder_4+ | Z+            | Z+      | Data+  | Data+     | Data+ for absolute encoders, or Z+ for both AqB and analog sin/cos encoder |
| 10    | Encoder_4- | Z-            | Z-      | Data-  | Data-     | Data- for absolute encoders, or Z- for both AqB and analog sin/cos encoder |

|                              |                                   |
|------------------------------|-----------------------------------|
| Connector manufacturer       | SUNCHU                            |
| Mating connector part number | SC-10-4P                          |
| Wiring                       | AWG 26, insulation rated for 100V |



#### Note – Incremental encoder interface

Each differential-pair includes a built-in 120Ω terminator and the required hardware circuits to detect a disconnected encoder cable. When a disconnected encoder cable is detected, the controller will disable the motor. The detection is done on the A and B channels only (not on the index/Z-channel).

By default, the product does not support single-ended encoder. For use of single-ended encoder, contact Technical Support.

**Note – 5V supply limitation**

The 5V supply provided at pin 1 on each connector (X8 and X9) is limited to 0.5A per connector.

The maximum total current provided by all the 5V pins in the product is limited to 1.5A.

**3.6.6 Interfaces X7 and X8: I/Os**

Connectors X7 and X8 are used for connecting external I/O devices to the amplifier.

For schematics and more information about these interfaces, refer to the section Electrical Interfaces Circuit Diagrams.

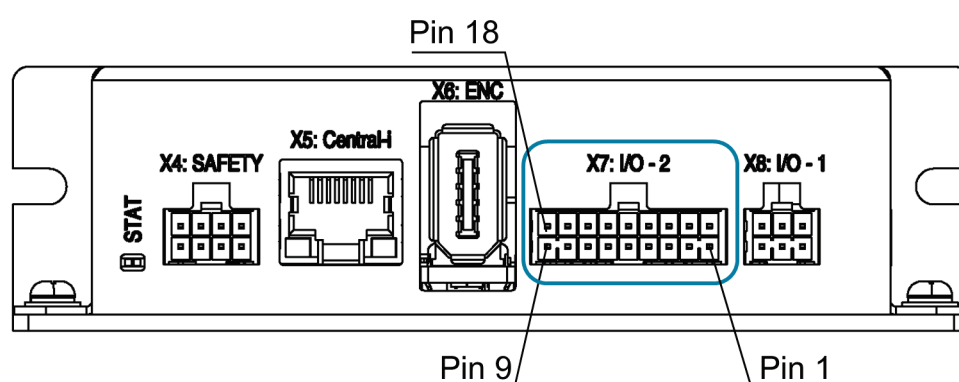
**Interface X7**

Figure 31. I/O-2 connector

**Connector X7: I/O-2**

| Pin # | Name                                  | Software Representation | Description                                                                                  |
|-------|---------------------------------------|-------------------------|----------------------------------------------------------------------------------------------|
| 1     | Vin_24V_IO_RTN                        |                         | I/O power return                                                                             |
| 2     | Vin_24V_IO                            |                         | 24V I/O power                                                                                |
| 3     | Digital_Output_Common_Return (1 to 2) |                         | Common power pin for isolated digital outputs 1 to 2                                         |
| 4     | Digital_Output_Common_Power (1 to 2)  |                         | Common power return pin for isolated digital outputs 1 to 2                                  |
| 5     | Digital_Input_7                       | DInPort.bit(6)          | Isolated digital input 7 (NPN or PNP, depending on the connection of the group's common pin) |
| 6     | Digital_Input_5                       | DInPort.bit(4)          | Isolated digital input 5 (NPN or PNP, depending on the connection of the group's common pin) |
| 7     | Digital_Input_Common (4 to 7)         |                         | Common pin (power or return, depending on external connection) for digital inputs 4 to 7     |

| Pin # | Name                  | Software Representation           | Description                                                                                                                                                                                |
|-------|-----------------------|-----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 8     | Bi-Dir_Diff_IO_1+     | DInPort.bit(7)<br>DOutPort.bit(2) | Bi-directional differential I/O 1+<br>Software configurable: <ul style="list-style-type: none"> <li>BiDirConfig.bit(0) = 0 for input</li> <li>BiDirConfig.bit(0) = 1 for output</li> </ul> |
| 9     | Analog_Input_1        | AINPort.bit(0)                    | Analog input 1, $\pm 12V$ , 12 bit                                                                                                                                                         |
| 10    | GND_EARTH             |                                   | Protective earth                                                                                                                                                                           |
| 11    | GND                   |                                   | GND for 5V and differential signals                                                                                                                                                        |
| 12    | 5V                    |                                   | 5V supply for external I/O circuits. Limited to 0.5A                                                                                                                                       |
| 13    | Digital_Output_2      | DOutnPort.bit(1)                  | Isolated digital output 2, programmable sink or source                                                                                                                                     |
| 14    | Digital_Output_1      | DOutnPort.bit(0)                  | Isolated digital output 1, programmable sink or source                                                                                                                                     |
| 15    | Digital_Input_6       | DInPort.bit(5)                    | Isolated digital input 6 (NPN or PNP, depending on the connection of the group's common pin)                                                                                               |
| 16    | Digital_Input_4       | DInPort.bit(3)                    | Isolated digital input 4 (NPN or PNP, depending on the connection of the group's common pin)                                                                                               |
| 17    | Bi-Dir_Diff_IO_1-     | DInPort.bit(7)<br>DOutPort.bit(2) | Bi-directional differential I/O 1-<br>Software configurable: <ul style="list-style-type: none"> <li>BiDirConfig.bit(0) = 0 for input</li> <li>BiDirConfig.bit(0) = 1 for output</li> </ul> |
| 18    | Analog_Input_Return_1 |                                   | Analog input 1 return.<br>Not connected internally to GND.                                                                                                                                 |

|                              |                                   |
|------------------------------|-----------------------------------|
| Connector manufacturer       | Samtec Inc                        |
| Mating connector part number | IPD1-06-D-K                       |
| Crimp part number            | CC79L-2630-01-L                   |
| Wiring                       | 26 AWG, insulation rated for 100V |

## Interface X8

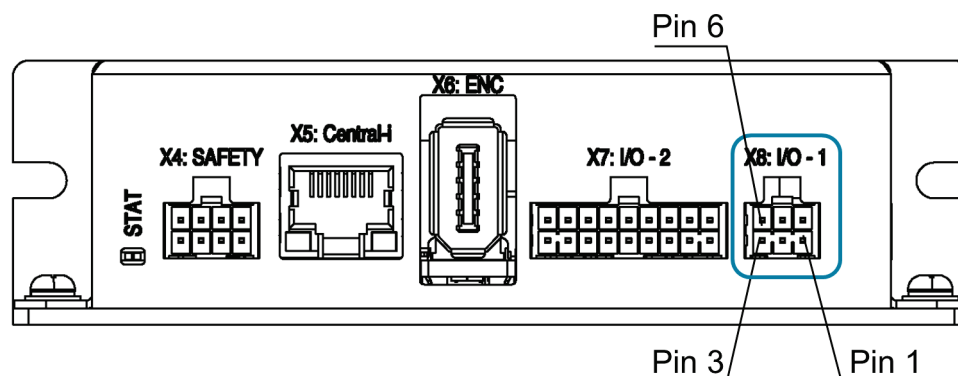


Figure 32. I/O-1 connector

## Connector X8: I/O-1

| Pin # | Name                          | Software Representation | Description                                                                                  |
|-------|-------------------------------|-------------------------|----------------------------------------------------------------------------------------------|
| 1     | 5V_SW1                        |                         | 5V supply for external I/O circuits. Limited to 0.5A                                         |
| 2     | Digital_Input_2               | DinPort.bit(1)          | Isolated digital input 2 (NPN or PNP, depending on the connection of the group's common pin) |
| 3     | Digital_Input_Common (1 to 3) |                         | 24V I/O power                                                                                |
| 4     | GND                           |                         | Ground for 5V and differential signals                                                       |
| 5     | Digital_Input_3               | DinPort.bit(2)          | Isolated digital input 3 (NPN or PNP, depending on the connection of the group's common pin) |
| 6     | Digital_Input_1               | DinPort.bit(0)          | Isolated digital input 1 (NPN or PNP, depending on the connection of the group's common pin) |

|                              |                                   |
|------------------------------|-----------------------------------|
| Connector manufacturer       | Samtec Inc                        |
| Mating connector part number | IPD1-06-D-K                       |
| Crimp part number            | CC79L-2630-01-L                   |
| Wiring                       | 26 AWG, insulation rated for 100V |

**Note – 5V supply limitation**

The 5V supply provided at pin 12 on connector X7 and pin 8 on connector X12 is limited to 0.5A (both pins together).

The maximum total current provided by all the 5V pins in the product is limited to 1.5A.

### 3.6.7 Interface J5: Central-i

Connector X5 is used for communication with the Central-i master controller, such as the AGM800, and other remote amplifiers and devices.

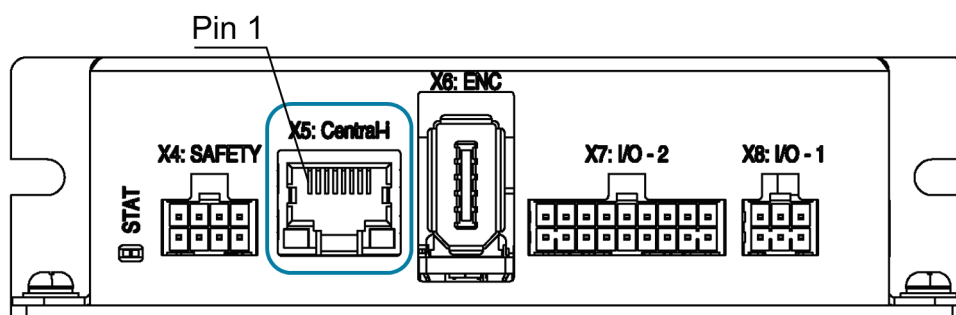


Figure 33. Communication connector (Central-i)

#### Connector: Central-i (RJ45)

| Pin # | Name                    | Description             |
|-------|-------------------------|-------------------------|
| 1     | Central-i data0+        | Bi-directional + data + |
| 2     | Central-i data0-        | Data -                  |
| 3     | Central-i data1+        | Data +                  |
| 4     | Central-i data2-        | Bi-directional +        |
| 5     | BI-_D3 Central-i data2+ | Bi-directional +        |
| 6     | RX-_D2 Central-i data1- | Receive data -          |
| 7     | BI+_D45V_CI             | Bi-directional +        |
| 8     | BI-_D4CI_GND            | Bi-directional -        |

|                              |                                                   |
|------------------------------|---------------------------------------------------|
| Connector type               | RJ45 LAN 10/100Base-T connector                   |
| Mating connector part number | Any CAT5e compatible shielded connector           |
| Cable                        | CAT5e or higher, standard Ethernet straight cable |

## 3.7 AGA103 – Electrical Interfaces

### 3.7.1 Interface X5: Main Power

Connector X2 is used to supply 12–48 VDC to the AGA103. The input voltage is connected directly to the amplifier power bridge. The input voltage drive the axis motor. It also supplies the power for the amplifier internal logic.

The amplifier includes protection to prevent damage if polarity is inverted at the power input.



#### Note – Optional scheme for isolated power supplies

The amplifier can support fully isolated power supplies, one for the power circuitry to drive the motor, and one for the digital logic. If you are interested in such a scheme, contact Technical Support.

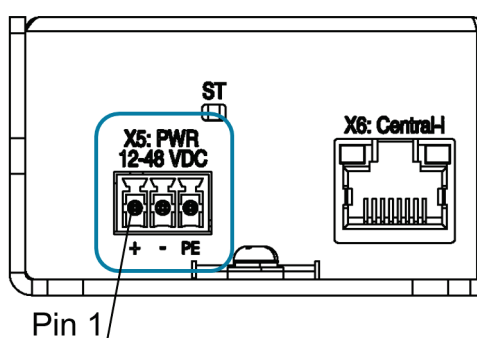


Figure 34. Power connector

#### Connector X5: PWR

| Pin # | Name | Description                              |
|-------|------|------------------------------------------|
| 1     | Vin  | Power input: 12–48V, up to 8A continuous |
| 2     | GND  | Ground                                   |
| 3     | PE   | Protective earth                         |

|                              |                                      |
|------------------------------|--------------------------------------|
| Connector manufacturer       | WURTH                                |
| Mating connector part number | 691361100003                         |
| Connector Pitch              | 3.50 mm                              |
| Wiring                       | AWG 16–26, insulation rated for 300V |

### 3.7.2 Interface X4: Safety

Connector X4 is used for the hardware safety function that disables power to the motor.

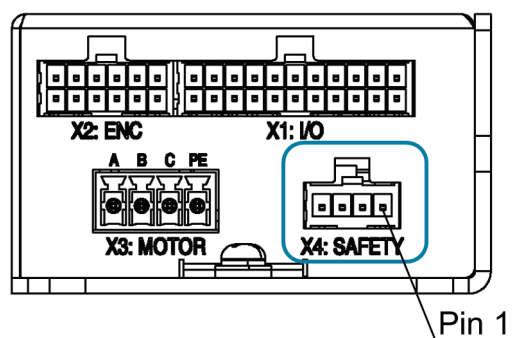


Figure 35. Safety connector

#### Connector X4: SAFETY

| Pin # | Name           | Description                   |
|-------|----------------|-------------------------------|
| 1     | Safety 5V      | 5V supply for safety circuits |
| 2     | Safety Input + | Safety_Input positive input   |
| 3     | Safety Input - | Safety_Input negative input   |
| 4     | GND            | Ground                        |

|                              |                                   |
|------------------------------|-----------------------------------|
| Connector manufacturer       | SAMTEC                            |
| Mating connector part number | IPD1-04-S                         |
| Crimp contact part number    | CCC79L-2630-01-L (or equivalent)  |
| Wiring                       | AWG 26, insulation rated for 100V |

#### Safety connector circuit diagram

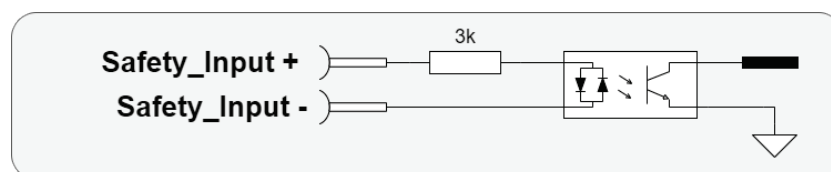


Figure 36. Electrical interfaces – safety connector

- Safety\_Input disables the power to the motor through hardware circuitry, without any software intervention.
- Safety\_Input is defined with a positive pin (+) and a negative pin (-). However, the opto-coupler at the Safety\_Input has two input diodes, which enable operation at "positive" or "negative" input voltage. The input is activated when current is sufficient at one of the input diodes, regardless of the current direction. This enables NPN or PNP connection to the safety inputs.

- The Safety\_Input protection logic is designed so that Safety\_Input must be powered to enable motor operation. Leaving a Safety\_Input disconnected prevents motor operation. This logic is required to ensure that a disconnected safety cable is considered an unsafe condition by the control unit. When sufficient current is driven through a Safety\_Input, the state of this input is Safe. When insufficient current is driven through a Safety\_Input, the state of this input is Unsafe.
- The Safety\_Input must be in the Safe state to enable motor operation.
- The electrical characteristics of the Safety\_Input is identical to those of all other isolated digital inputs of the controller.
- The safety inputs implemented in the product are currently pending certification Functional Safety Standards.

### 3.7.3 Interface X3: Motor

Connector X3 serves to supply power to the motor, which can be a 3-phase brushless motor, a single phase brushed motor, a voice coil motor, or a stepper motor.

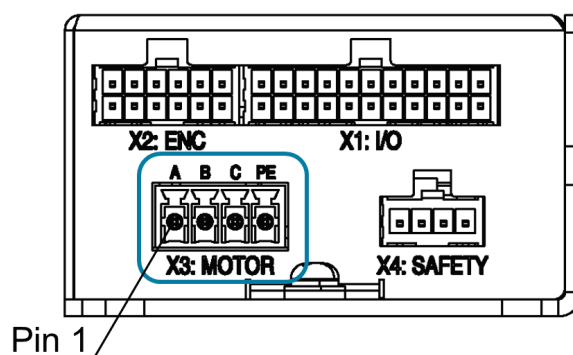


Figure 37. Motor connector

#### Connector X3: MOTOR

| Pin # | Name | Brushless Motor  | Brushed or Voice Coil Motor | Stepper Motor                              |
|-------|------|------------------|-----------------------------|--------------------------------------------|
| 1     | A    | Motor phase A    | Motor phase +               | Motor phase 1+                             |
| 2     | B    | Motor phase B    | Motor phase -               | Motor phase 2+                             |
| 3     | C    | Motor phase C    | Not connected               | Motor phases 1- and 2-<br>(see Note below) |
| 4     | PE   | Protective earth | Protective earth            | Protective earth                           |

|                              |                                       |
|------------------------------|---------------------------------------|
| Connector manufacturer       | WURTH                                 |
| Mating connector part number | 691361100004                          |
| Connector Pitch              | 3.50 mm                               |
| Wiring                       | AWG 16–26, insulation rated for 300 V |



#### Note – Stepper voltage range

A bipolar stepper motor has two independent phases (4 wires in total). For the AGA102, you must connect the (-) wire of both phases together, to pin 3 on connector X3.

This connection implies a limitation of the voltage that will be applied to the stepper.

For example, if the power supply to the unit is 24V, each phase of the stepper motor will be limited to 12V.

With suitable selection of the power supply this should impose no limitation on the stepper motor operation.

### 3.7.4 Interface X2: Encoder

Connector X2 serves as an interface to a single encoder.

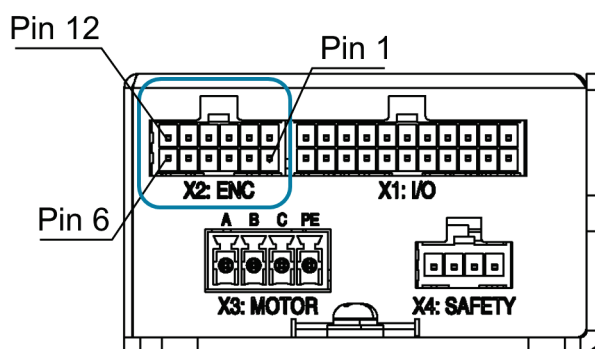


Figure 38. Encoder connector

#### Connector X2: ENC

| Pin # | Name       | Encoder Type |         |        |           | Description                                                                |
|-------|------------|--------------|---------|--------|-----------|----------------------------------------------------------------------------|
|       |            | AqB          | Sin/Cos | BiSS-C | EnDat 2.2 |                                                                            |
| 1     | 5V         |              |         |        |           | 5V power supply (limited to 0.3A per connector)                            |
| 2     | Encoder_1+ |              |         | Clock+ | Clock+    | Clock+ pin for absolute encoders                                           |
| 3     | Encoder_2+ | A+           | Sin+    |        |           | A+ (for AqB) or sin+ (for analog sin/cos)                                  |
| 4     | Encoder_3+ | B+           | Cos+    |        |           | B+ (for AqB) or cos+ (for analog sin/cos)                                  |
| 5     | Encoder_4+ | Z+           | Z+      | Data+  | Data+     | Data+ for absolute encoders, or Z+ for both AqB and analog sin/cos encoder |
| 6     | GND_EARTH  |              |         |        |           | Protective earth                                                           |
| 7     | GND        |              |         |        |           | 5V return and reference for differential signals                           |
| 8     | Encoder_1- |              |         | Clock- | Clock-    | Clock- pin for absolute encoders                                           |
| 9     | Encoder_2- | A-           | Sin-    |        |           | A- (for AqB) or sin- (for analog sin/cos)                                  |
| 10    | Encoder_3- | B-           | Cos-    |        |           | B- (for AqB) or cos- (for analog sin/cos)                                  |
| 11    | Encoder_4- | Z-           | Z-      | Data-  | Data-     | Data- for absolute encoders, or Z- for both AqB and analog sin/cos encoder |
| 12    | GND_EARTH  |              |         |        |           | Protective earth                                                           |

|                              |                                    |
|------------------------------|------------------------------------|
| Connector manufacturer       | SAMTEC                             |
| Mating connector part number | IPD1-06-D-K                        |
| Crimp contact part number    | CCC79L-2630-01-L (or equivalent)   |
| Wiring                       | AWG 26, insulation rated for 100 V |



#### Note – 5V supply limitation

The 5V supply provided at pin 1 on the connector is limited to 0.3A.  
The maximum total current provided by all the 5V pins in the product is limited to 1.5A.

### 3.7.5 Interface X1: I/Os

Connector X1 is used for connecting external I/O devices to the amplifier.

For schematics and more information about these interfaces, refer to the section Electrical Interfaces Circuit Diagrams.

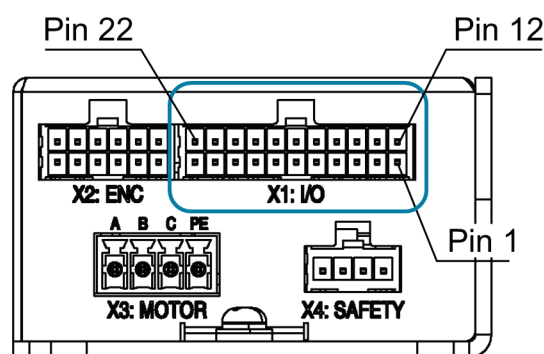


Figure 39. I/O connector

#### Connector X1: I/O

| Pin # | Name                          | Software Representation           | Description                                                                                                                                                                                 |
|-------|-------------------------------|-----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1     | 5V                            |                                   | 5V supply to Hall sensors. Connect to pin 4 when using digital inputs 3 to 5 for Hall sensors.                                                                                              |
| 2     | GND                           |                                   | Ground for 5V                                                                                                                                                                               |
| 3     | Bi-Dir_Diff_IO_2-             | DInPort.bit(6)<br>DOutPort.bit(3) | Bi-directional differential I/O 2-<br>Software configurable: <ul style="list-style-type: none"> <li>BiDirConfig.bit(1) = 0 for input</li> <li>BiDirConfig.bit(1) = 1 for output</li> </ul>  |
| 4     | Digital_Input_Common (3 to 5) |                                   | Common pin (power or return, depending on external connection) for digital input 3 to 5                                                                                                     |
| 5     | Digital_Input_4               | DInPort.bit(3)                    | Isolated digital input 4 (NPN or PNP, depending on the connection of the group's common pin)                                                                                                |
| 6     | Digital_Input_3 (Hall_C)      | DInPort.bit(2)                    | Isolated digital input 3 (NPN or PNP, depending on the connection of the group's common pin)                                                                                                |
| 7     | Digital_Input_2 (Hall_B)      | DInPort.bit(1)                    | Isolated digital input 2 (NPN or PNP, depending on the connection of the group's common pin)                                                                                                |
| 8     | Digital_Input_1 (Hall_A)      | DInPort.bit(0)                    | Isolated digital input 1 (NPN or PNP, depending on the connection of the group's common pin).<br>To use as Hall input, go to the Agito PCSuite Digital Input page, and configure as Hall A. |

| Pin # | Name                          | Software Representation           | Description                                                                                                                                                         |
|-------|-------------------------------|-----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 9     | Digital_Input_Common (1 to 2) |                                   | Common pin (power or return, depending on external connection) for digital input 1 to 2                                                                             |
| 10    | Digital_Output_1              | DOutPort.bit(0)                   | Isolated digital output 1, programmable sink or source                                                                                                              |
| 11    | Digital_Output_2              | DOutPort.bit(1)                   | Isolated digital output 2, programmable sink or source                                                                                                              |
| 12    | Bi-Dir_Diff_IO_1-             | DInPort.bit(5)<br>DOutPort.bit(2) | Bi-directional differential I/O 1-<br><ul style="list-style-type: none"> <li>BiDirConfig.bit(0) = 0 for input</li> <li>BiDirConfig.bit(0) = 1 for output</li> </ul> |
| 13    | Bi-Dir_Diff_IO_1+             | DInPort.bit(5)<br>DOutPort.bit(2) | Bi-directional differential I/O 1+<br><ul style="list-style-type: none"> <li>BiDirConfig.bit(0) = 0 for input</li> <li>BiDirConfig.bit(0) = 1 for output</li> </ul> |
| 14    | Bi-Dir_Diff_IO_2+             | DInPort.bit(6)<br>DOutPort.bit(3) | Bi-directional differential I/O 2+<br><ul style="list-style-type: none"> <li>BiDirConfig.bit(1) = 0 for input</li> <li>BiDirConfig.bit(1) = 1 for output</li> </ul> |
| 15    | Digital_Input_5               | DInPort.bit(4)                    | Isolated digital input 5 (NPN or PNP, depending on the connection of the group's common pin)                                                                        |
| 16    | Analog_Input_1                |                                   | Analog Input, return                                                                                                                                                |
| 17    | Analog_Input_Return_1         | AInPort[0]                        | Analog input, $\pm 12V$ full scale                                                                                                                                  |
| 18    | RTD +                         |                                   | PT100+                                                                                                                                                              |
| 19    | RTD -                         |                                   | PT100-                                                                                                                                                              |
| 20    | Digital_Output_Common_Power   |                                   | Common power pin for isolated digital outputs                                                                                                                       |
| 21    | Digital_Output_Common_Return  |                                   | Common power return pin for isolated digital outputs                                                                                                                |
| 22    | GND_EARTH                     |                                   | Protective earth                                                                                                                                                    |

|                              |                                    |
|------------------------------|------------------------------------|
| Connector manufacturer       | SAMTEC                             |
| Mating connector part number | IPD1-11-D-K                        |
| Crimp contact part number    | CCC79L-2630-01-L (or equivalent)   |
| Wiring                       | AWG 26, insulation rated for 100 V |

### 3.7.6 Interface X13: Central-i

Connector X5 is used for communication with the Central-i master controller, such as the AGM800, and other remote amplifiers and devices.

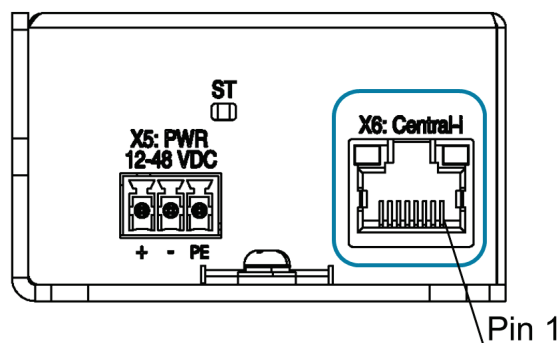


Figure 40. Communication connector (Central-i)

#### Connector X13: Central-i (RJ45)

| Pin # | Name                    | Description             |
|-------|-------------------------|-------------------------|
| 1     | Central-i data0+        | Bi-directional + data + |
| 2     | Central-i data0-        | Data -                  |
| 3     | Central-i data1+        | Data +                  |
| 4     | Central-i data2-        | Bi-directional +        |
| 5     | BI-_D3 Central-i data2+ | Bi-directional +        |
| 6     | RX-_D2 Central-i data1- | Receive data -          |
| 7     | BI+_D45V_CI             | Bi-directional +        |
| 8     | BI-_D4CI_GND            | Bi-directional -        |

|                              |                                                   |
|------------------------------|---------------------------------------------------|
| Connector type               | RJ45 LAN 10/100Base-T connector                   |
| Mating connector part number | Any CAT5e compatible shielded connector           |
| Cable                        | CAT5e or higher, standard Ethernet straight cable |
| Wiring                       | AWG 26, insulation rated for 100 V                |

## 3.8 Electrical Interfaces Circuit Diagrams

### 3.8.1 Isolated Digital Inputs

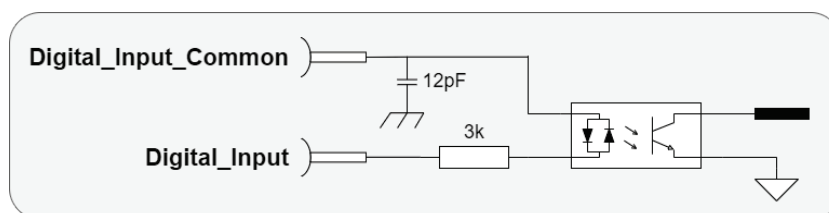


Figure 41. Isolated digital inputs

- Isolated digital inputs are organized as groups with a dedicated common pin. This enables connection to different voltage supplies. Each group is fully isolated and independent of the other groups.
- Each group can be connected as NPN or PNP interfaces, depending on the wiring of the group's common pin. If the common pin is connected to power (5V to 28V), then the inputs of this group can be used with external NPN devices (external current sinking devices). If the common is connected to the GND of some external power, then the inputs can be used with external PNP devices (external current sourcing devices).
- The input circuit of the opto-couplers includes two diodes. This enables use as NPN or PNP.
- One group can be wired to interface external NPN devices and another group can be wired to interface PNP devices. However, within a group, all interfaces (NPN or PNP) must be the same, as they are based on the connection of the group's common pin.

#### Isolated Inputs – Groups and Common Pins

##### AGA101

| Connector | Inputs       | Common |
|-----------|--------------|--------|
| X10       | 1, 2, 3, 4   | pin 5  |
| X7        | 5, 6, 7      | pin 6  |
| X12       | 8, 9, 10, 11 | pin 5  |

##### AGA102

| Connector | Inputs     | Common |
|-----------|------------|--------|
| X8        | 1, 2, 3    | pin 3  |
| X7        | 4, 5, 6, 7 | pin 7  |

##### AGA103

| Connector | Inputs  | Common |
|-----------|---------|--------|
| X1        | 1, 2    | pin 9  |
| X1        | 3, 4, 5 | pin 4  |

### 3.8.2 Isolated Digital Outputs

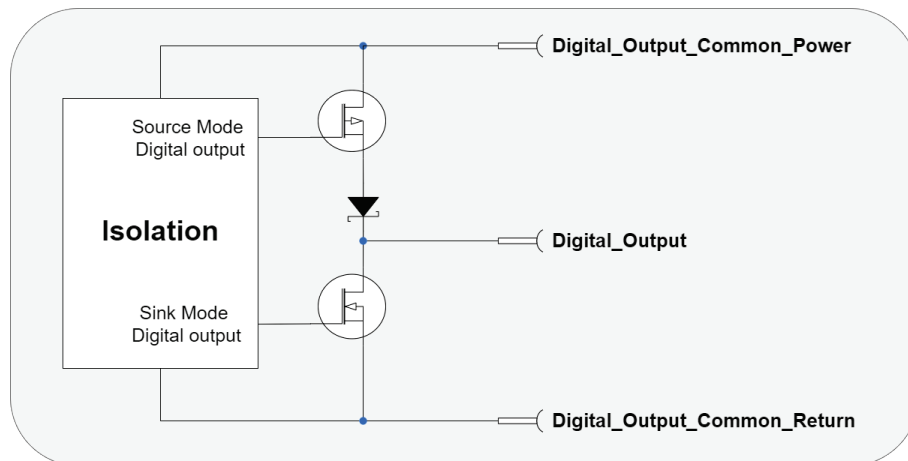


Figure 42. Isolated digital outputs – AGA101 and 102

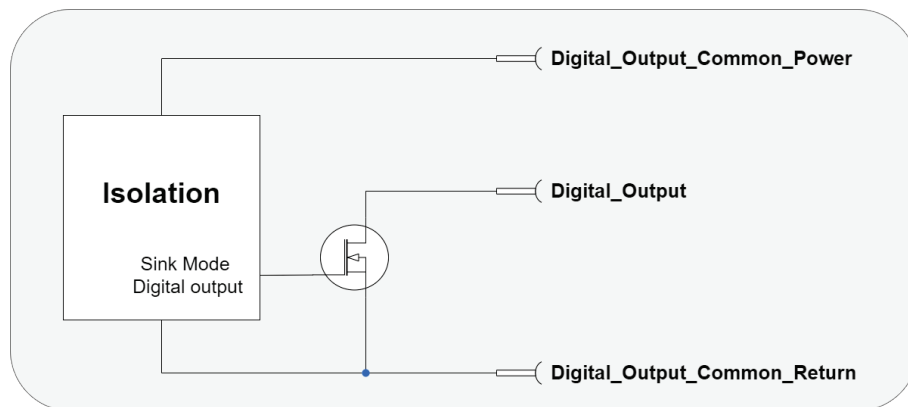


Figure 43. Isolated digital outputs – AGA103

- The digital output interface circuit is identical for all outputs.
- Each output can be programmed (by a software parameter) to act as a current sourcing output (up to 300mA) or as a current sinking output (up to 500mA).



#### Note – AGA103

In AGA103, the digital isolated outputs can be configured only as sinking.

- Digital\_Output\_Common\_Power is shared by all 3 outputs.
- The outputs are designed for resistive loads. For inductive loads, an external flyback diode is required.
- Digital outputs specifications:
  - Digital\_Output\_Common\_Power voltage range is between 5V and 28V.
  - Maximal load current, per each output:
 

|                                                     |                        |
|-----------------------------------------------------|------------------------|
| Sink mode, any Digital_Output_Common_Power voltage: | 500 mA                 |
| Source mode, at 24V Digital_Output_Common_Power:    | 300 mA                 |
| Source mode, at 5V Digital_Output_Common_Power:     | 60 mA (see Note below) |



#### Note – 5V Digital\_Output\_Common\_Power source mode limitation.

When using 5V Digital\_Output\_Common\_Power, higher current (but less than the absolute maximum value of 250 mA) can be driven. However, the output high voltage will drop significantly. To maintain output high voltage at >4.5V, limit the current to 60 mA.

### 3.8.3 Analog Input

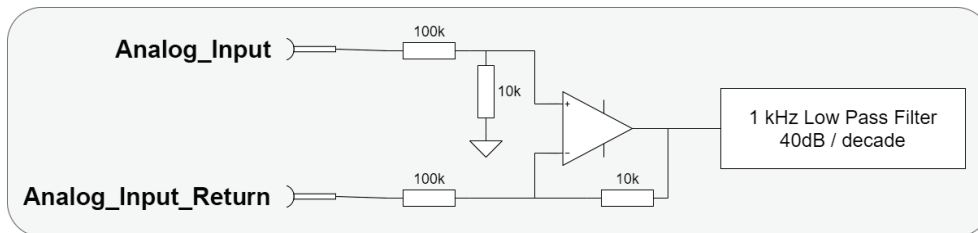


Figure 44. Analog inputs

- The electrical interfaces of all analog inputs are identical on AGA101, AGA102, and AGA103..
- The analog input range is -12V to +12V, and resolution is 12 bits.
- The analog input is designed for standard differential analog input, with a simple input circuit, having an input resistance of ~60 kW.
- Input circuit bandwidth: 1 kHz, -40 dB/decade
- The controller software provides the following parameters to control the analog input reading:
  - Filter
  - Offset
  - Deadband
  - Gain

### 3.8.4 Differential Inputs

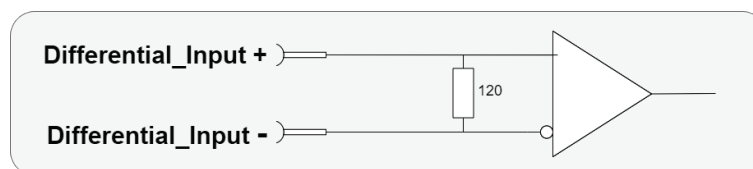


Figure 45. Differential inputs

- Differential inputs use two complementary signals (Differential\_Input+ and Differential\_Input-) to receive information.
- The same electrical signal is sent as a differential pair, each in its own conductor. The pair is wired as a twisted pair.
- The differential inputs in the AGA10x amplifiers are implemented according to the RS422 standard.

### 3.8.5 Differential Outputs

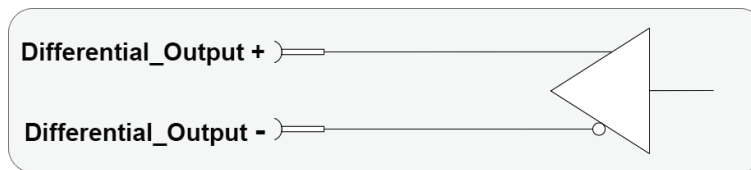


Figure 46. Differential outputs

- Differential outputs use two complementary signals (Differential\_Output+ and Differential\_Output-) to receive information.
- The same electrical signal is sent as a differential pair, each in its own conductor. The pair is wired as a twisted pair.
- The differential outputs in the AGA10x amplifiers are implemented according to the RS422 standard.

### 3.8.6 Bi-directional Differential I/Os

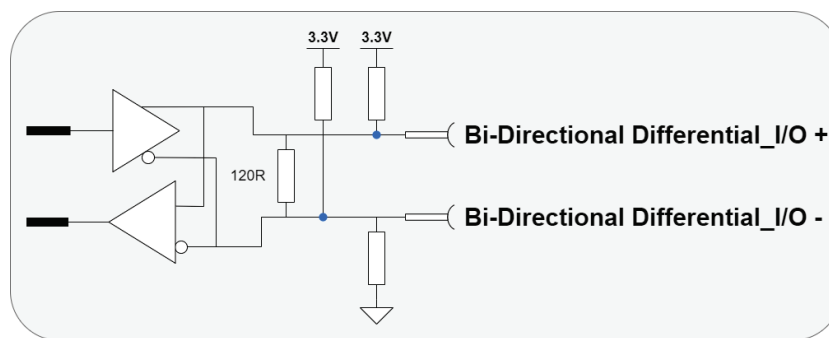


Figure 47. Bi-directional differential I/Os

- The bi-directional differential output is configurable by software to be a differential output or differential input.
- Both + and - pins are pulled up to 3.3V.
- There is a 120W termination resistor between the + and - pins.

### 3.8.7 Hall Sensors

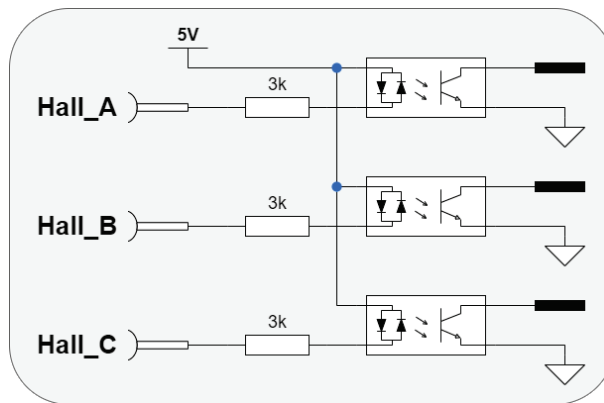


Figure 48. Motor Hall sensors

- Motor Hall sensors are wired as standard digital inputs.
- Hall\_A, Hall\_B, and Hall\_C are connected, respectively, to the corresponding input 1, input 2, and input 3.

## 4 Operation

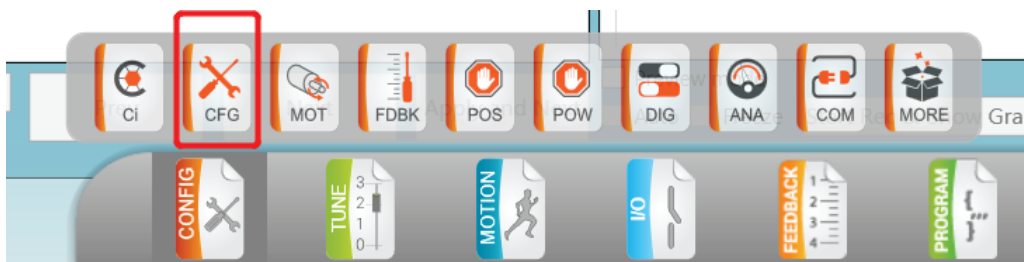
### 4.1 Motor Configuration

This manual uses the product with a linear DC brushless motor as an example for illustration of the configuration and operation. For advanced configuration and operation, refer to the respective software manuals.

1. Connect the product to power supply, motor, encoder and other I/Os according to the descriptions in the *Electrical Interfaces* section.

Make sure the safety port is connected before any operation.

2. Open Agito PCSuite software. Select CFG in CONFIG below and setup the parameters as follows:



**Basic Configuration**

System

Operation mode: 3 - Position control

The controller supports multiple methods for on-the-fly mode switching. Please refer to the most updated User's Manual.

Amplifier type: 0 - Built In PWM amplifier (DRV product)

Power supply: 1 - Single phase

Static brake ☐ Use

Static brake mode: 2 - Manual Release Command – without Protec

Brake lock time: 100 Brake release time: 100 msec

Dynamic brake ☒ Use

Speed threshold: 2,000 user-units/sec

Regeneration ☐ Use

Activate at: 360,000 mV Deactivate at: 340,000 mV

Figure 49. Operation mode configuration

3. Click **Next** and set the motor type and number of pole pairs according to the test motor.

**Motor**

Motor Parameters

Type: 3 - Linear DC Brushless

Number of pole pairs: 1

Figure 50. Select motor type

4. Click **Next** to setup the position feedback parameters. The definition of **Resolution** depends on the motor and encoder type. For rotary motor and rotary encoder, it is the number of encoder counts per mechanical revolution. For linear motor, it is the number of encoder counts per magnetic pitch (one pole-pair).

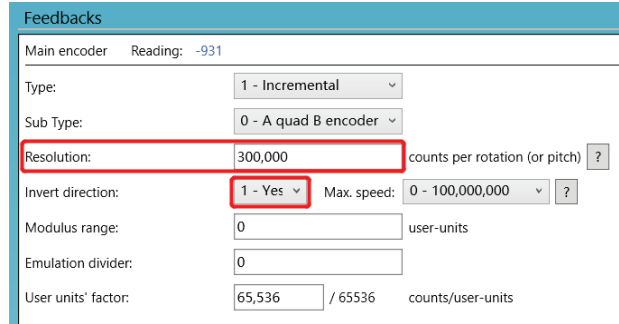


Figure 51. Feedback parameters

The value of **Invert direction** affects commutation of the motor. The encoder must be moving in the positive direction during auto-phasing process.

- Click **Next** to setup position, velocity and motor stuck protection. Fill in the limits according to the application requirements.

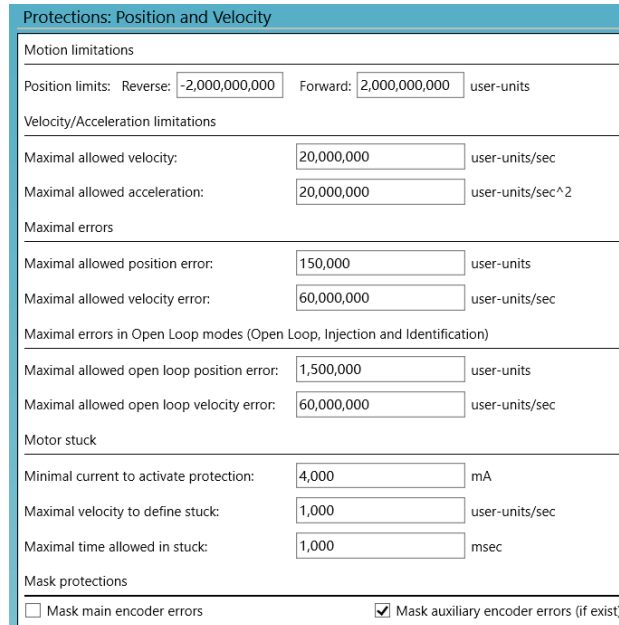


Figure 52. Position and velocity protection

- Click **Next** to configure current and voltage limits. It is important to refer to motor's specifications. The limits entered here must be within the motor operating limits to avoid damaging the motor.

| Protections: Power and Current                                   |                                      |                 |
|------------------------------------------------------------------|--------------------------------------|-----------------|
| Current limitations and protections                              |                                      | Current units ? |
| Continuous limitation:                                           | <input type="text" value="1,000"/>   | mA              |
| Peak limitation:                                                 | <input type="text" value="5,000"/>   | mA              |
| Peak maximum time:                                               | <input type="text" value="1,000"/>   | msec            |
| Maximal phase current:                                           | <input type="text" value="4,750"/>   | mA              |
| Maximal allowed motor current:                                   | <input type="text" value="4,750"/>   | mA              |
| <i>Current protections should be higher than Peak limitation</i> |                                      |                 |
| Maximal allowed power unit temperature:                          | <input type="text" value="65"/>      | °C              |
| Motor temperature sensor (PT100):                                | <input type="checkbox"/> Connected   |                 |
| Maximal allowed motor temperature:                               | <input type="text" value="80"/>      | °C              |
| Bus voltage protections                                          |                                      |                 |
| Minimal allowed bus voltage:                                     | <input type="text" value="150,000"/> | mV              |
| Maximal timed bus voltage:                                       | <input type="text" value="360,000"/> | mV              |
| Maximal time for over voltage:                                   | <input type="text" value="0"/>       | ms              |
| Absolute maximal allowed bus voltage:                            | <input type="text" value="360,000"/> | mV              |
| PWM limitations                                                  |                                      |                 |
| PWM limitations:                                                 | <input type="text" value="90"/>      | %               |

Figure 53. Current and voltage protection

## 4.2 Drive/Motor Overload Protection

The following methods are used to protect the AGA10x from overload:

- I<sup>2</sup>T
- Motor stuck
- Motor temperature protection using a PT100 or PT1000.

### 4.2.1 I<sup>2</sup>T Over Load Protection

In a transient condition, the motor can sustain a certain amount of energy that exceeds the continuous limit. However, the more the current value exceeds the continuous current, the less time the current value can be sustained, and vice versa.

If the maximal energy level is surpassed, the maximal current is limited to the continuous current, instead of being limited to the peak current as usual.

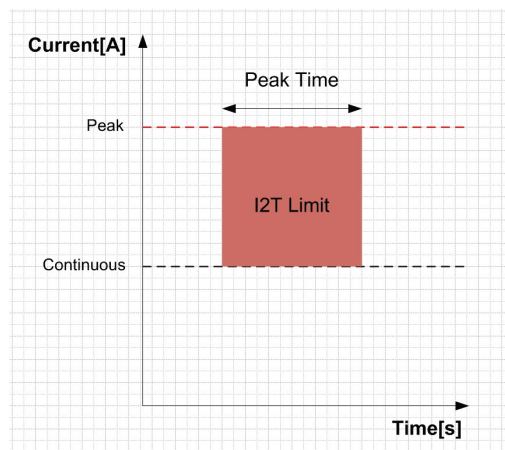


Figure 54. I<sup>2</sup>T

In Agito PCSuite, the following parameters define the  $I^2T$  characteristics:

- Peak current
- Continuous current
- Peak time

| Protections: Power and Current      |       |                 |
|-------------------------------------|-------|-----------------|
| Current limitations and protections |       | Current units ? |
| Continuous limitation:              | 2,000 | mA              |
| Peak limitation:                    | 4,000 | mA              |
| Peak maximum time:                  | 1,000 | msec            |

Figure 55. I<sup>2</sup>T settings



**Note** – The I<sup>2</sup>T algorithm does not support thermal memory protection or thermal memory during power loss.

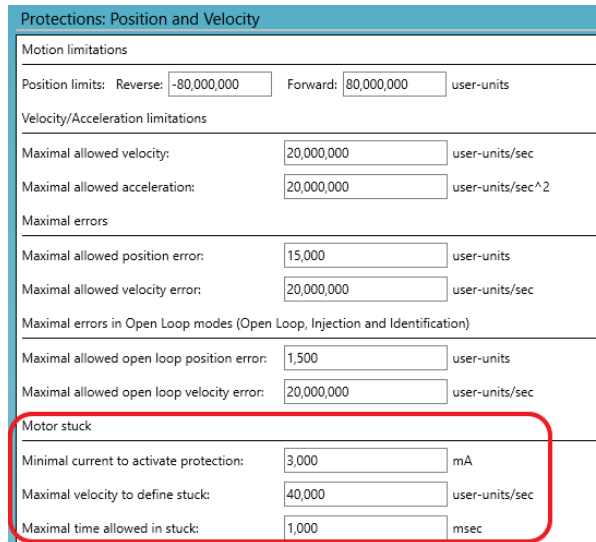
On drive power-up, the algorithm does not consider the amount of energy supplied to the motor prior to power-up.



Note – The I2T algorithm does not consider motor speed. Therefore, the product does not support thermal speed sensitivity.

## 4.2.2 Motor Stuck

Motor stuck indicates whether or not the motor is in fact stuck. The condition is strongly dependent on the application.



| Protections: Position and Velocity                                                 |                             |
|------------------------------------------------------------------------------------|-----------------------------|
| <b>Motion limitations</b>                                                          |                             |
| Position limits: Reverse:                                                          | -80,000,000 user-units      |
| Forward:                                                                           | 80,000,000 user-units       |
| <b>Velocity/Acceleration limitations</b>                                           |                             |
| Maximal allowed velocity:                                                          | 20,000,000 user-units/sec   |
| Maximal allowed acceleration:                                                      | 20,000,000 user-units/sec^2 |
| <b>Maximal errors</b>                                                              |                             |
| Maximal allowed position error:                                                    | 15,000 user-units           |
| Maximal allowed velocity error:                                                    | 20,000,000 user-units/sec   |
| <b>Maximal errors in Open Loop modes (Open Loop, Injection and Identification)</b> |                             |
| Maximal allowed open loop position error:                                          | 1,500 user-units            |
| Maximal allowed open loop velocity error:                                          | 20,000,000 user-units/sec   |
| <b>Motor stuck</b>                                                                 |                             |
| Minimal current to activate protection:                                            | 3,000 mA                    |
| Maximal velocity to define stuck:                                                  | 40,000 user-units/sec       |
| Maximal time allowed in stuck:                                                     | 1,000 msec                  |

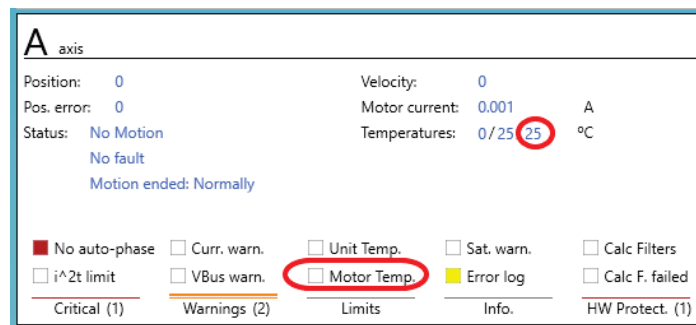
Figure 56. Motor stuck settings

The protection feature monitors and responds to a condition in which the amplifier is providing a certain amount of minimal current (StuckCurr), but the motor does not move at the minimal expected speed (StuckVel) for a certain amount of time (StuckTime). If this condition occurs, the motor will be shut off.

## 4.2.3 Motor Temperature Protection

If the motor temperature sensor option is selected, the AGA10x will monitor the PT100/1000 temperature sensor readings, and display warnings in the status window if the temperature is approaching the specified limit.

If the temperature exceeds the specified limit, the motor will be shut off.



| A axis                                                                                                                                                                                                          |                                                    |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|
| Position: 0                                                                                                                                                                                                     | Velocity: 0                                        |
| Pos. error: 0                                                                                                                                                                                                   | Motor current: 0.001 A                             |
| Status: No Motion                                                                                                                                                                                               | Temperatures: 0/25 25 °C                           |
| No fault                                                                                                                                                                                                        |                                                    |
| Motion ended: Normally                                                                                                                                                                                          |                                                    |
| <input checked="" type="checkbox"/> No auto-phase <input type="checkbox"/> Curr. warn. <input checked="" type="checkbox"/> Unit Temp. <input type="checkbox"/> Sat. warn. <input type="checkbox"/> Calc Filters |                                                    |
| <input type="checkbox"/> i^2t limit <input type="checkbox"/> VBus warn. <input checked="" type="checkbox"/> Motor Temp. <input type="checkbox"/> Error log <input type="checkbox"/> Calc F. failed              |                                                    |
| Critical (1)                                                                                                                                                                                                    | Warnings (2)    Limits    Info.    HW Protect. (1) |

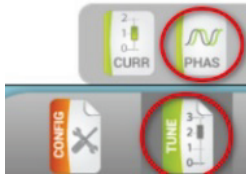
Figure 57. Axis status

| Protections: Power and Current          |                                    |                 |
|-----------------------------------------|------------------------------------|-----------------|
| Current limitations and protections     |                                    | Current units ? |
| Continuous limitation:                  | 2,000                              | mA              |
| Peak limitation:                        | 4,000                              | mA              |
| Peak maximum time:                      | 1,000                              | msec            |
| Maximal phase current:                  | 4,750                              | mA              |
| Maximal allowed motor current:          | 4,750                              | mA              |
| Maximal allowed power unit temperature: | 80                                 | °C              |
| Motor temperature sensor (PT100):       | <input type="checkbox"/> Connected |                 |
| Maximal allowed motor temperature:      | 80                                 | °C              |

Figure 58. Motor temperature settings

## 4.3 Tuning

### 4.3.1 Commissioning



This step is required only for brushless motor.

Select TUNE > PHAS. in the tune option.

Configure the main encoder resolution. For Auto-Phasing mode, select **Automatic upon power on** if the application allows “shake and wake” upon power up. If not, select **Automatic upon MotorOn (if needed)** to “shake and wake” only when the motor is ready for motor on.

Use **Jump to zero phase** for Auto-Phasing method for most reliable result. This method requires the longest search distance. If the stroke does not allow such search distance, select **Minimal Motion** method.

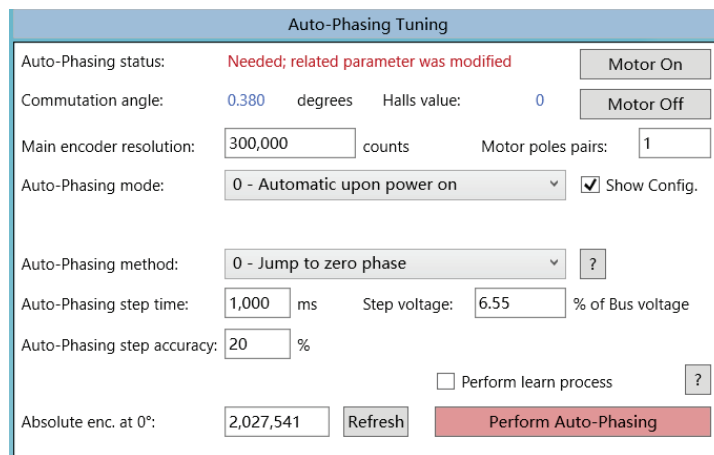


Figure 59. Auto-phasing for brushless motor

If the system does not allow any motion during power-on or motor-on, use Hall sensors for commutation phasing.

- Connect Hall sensors to HALLS port and configure the first of the three inputs in the digital I/O page as **Hall A**.
- Use the **Jump to zero phase** method to establish the motor and Hall phases; select **Perform learn process** and click **Perform Auto-Phasing**.
- After the auto-phasing is completed successfully, change the Auto-Phasing method to **Encoder with Halls/Encoder switching** and save all parameters to flash. After reset or power cycle of the controller, auto-phasing will be done by Hall sensors.

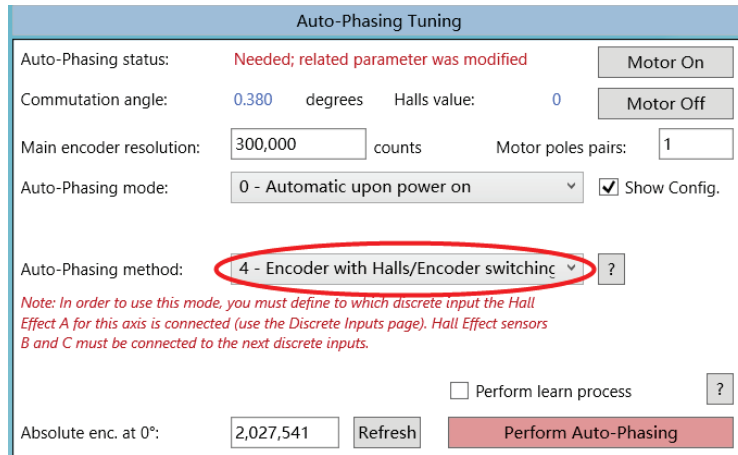
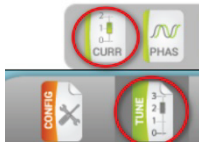


Figure 60. Using Hall sensors to avoid "shake and wake"

### 4.3.2 Current Loop Tuning



Select TUNE > CURR.

Enter motor's phase resistance and phase inductance according to the motor's datasheet and enter the desired current loop bandwidth for this axis. Typically, 1000 Hz is suitable for most applications.

Click **Calculate PI** to calculate the current loop gains.

Check both checkboxes for auto data recording and user predefined data recording.

Click **Apply Current Command** to test the current loop performance.

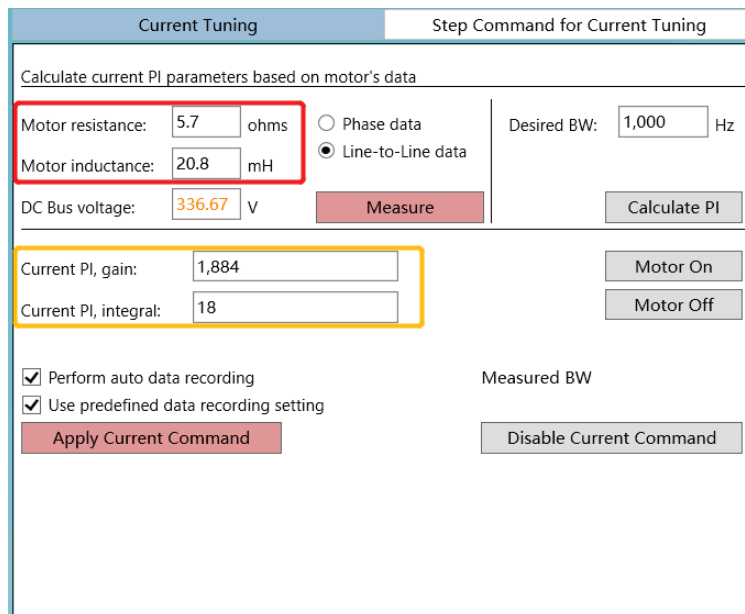


Figure 61. Current loop tuning

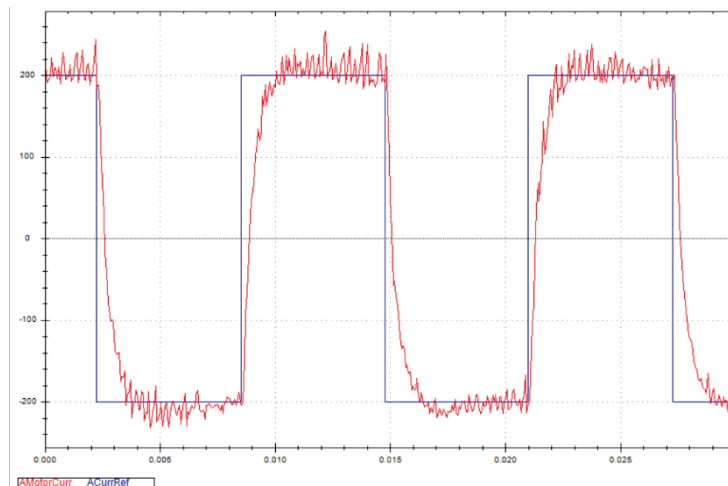


Figure 62/ Typical current loop performance

### 4.3.3 Auto Velocity and Position Loop Tuning

#### 1. System Identification.

Select TUNE > IDEN.

Click **Begin Identification** to perform system identification.

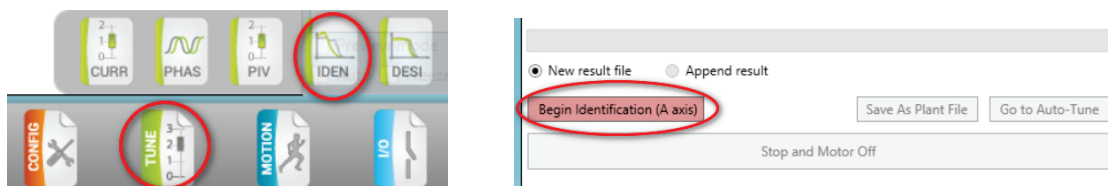


Figure 63. Begin System Identification

When the identification is completed successfully, the plant's transfer function will be displayed, as shown in the following figure.

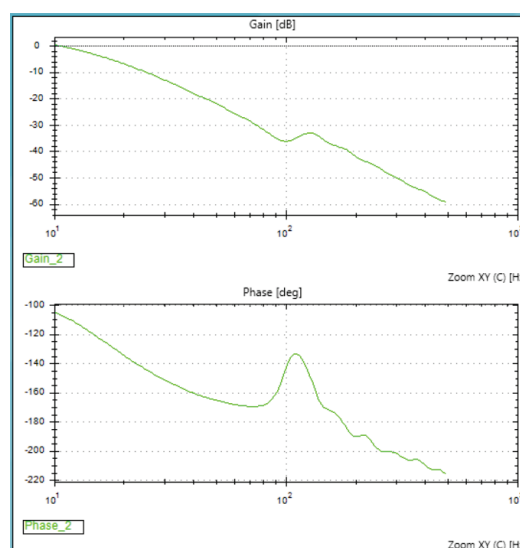


Figure 64. Typical plant transfer function

- Click **Go to Auto-Tune**. Alternatively, select TUNE-> DESI to open the Auto-Tuning (controller design) page.

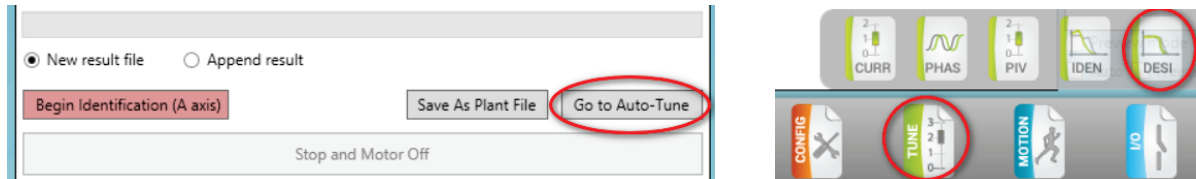


Figure 65. Go to Auto-Tuning page

- Click **Run Auto-Tune** to start Auto-Tuning. It will take a few seconds, or longer for more complex systems, to calculate the optimum PIV gains for this plant.

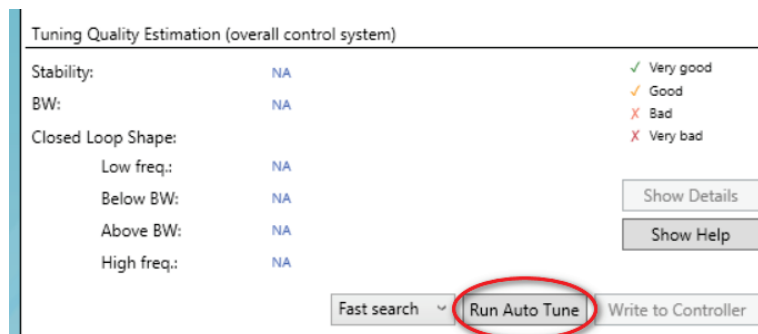


Figure 66. Start Auto-Tuning calculation

- Once Auto-Tuning is completed, click **Write to Controller** to download the calculated gains into the controller.

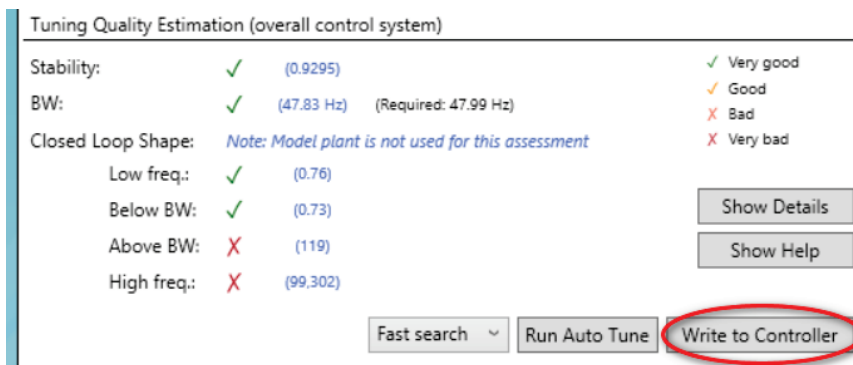
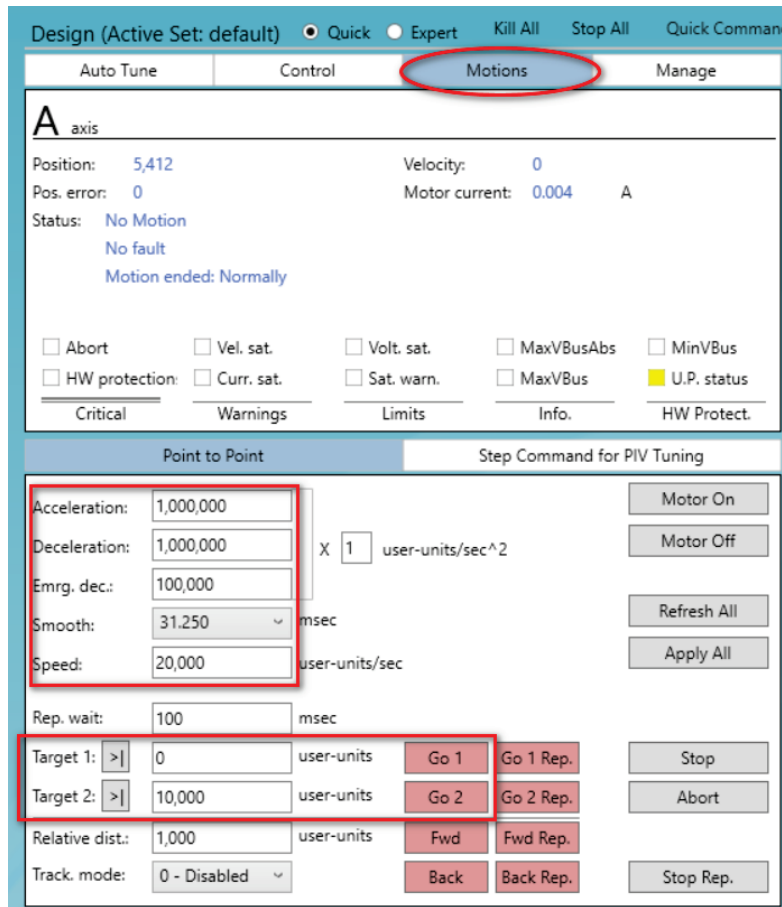


Figure 67. Download the parameters to the controller

5. Check the motion performance in the Motions Tab, set the required motion profile, and click **Go 1** or **Go 2** to move to Target 1 or Target 2. Record the motion data to analyze the motion performance in detail.



Design (Active Set: default) ☒ Quick ☐ Expert Kill All Stop All Quick Command

Auto Tune Control **Motions** Manage

**A** axis

Position: 5,412 Velocity: 0  
Pos. error: 0 Motor current: 0.004 A  
Status: No Motion  
No fault  
Motion ended: Normally

☐ Abort ☐ Vel. sat. ☐ Volt. sat. ☐ MaxVBusAbs ☐ MinVBus  
☐ HW protection: ☐ Curr. sat. ☐ Sat. warn. ☐ MaxVBus ☒ U.P. status

Critical Warnings Limits Info. HW Protect.

Point to Point Step Command for PIV Tuning

Acceleration: 1,000,000 X 1 user-units/sec<sup>2</sup>  
Deceleration: 1,000,000  
Emerg. dec.: 100,000  
Smooth: 31.250 msec  
Speed: 20,000 user-units/sec  
Rep. wait: 100 msec

Target 1: >| 0 user-units Go 1 Go 1 Rep.  
Target 2: >| 10,000 user-units Go 2 Go 2 Rep.  
Relative dist.: 1,000 user-units Fwd Fwd Rep.  
Track. mode: 0 - Disabled Back Back Rep.

Motor On  
Motor Off  
Refresh All  
Apply All  
Stop  
Abort  
Stop Rep.

Figure 68. Testing motion

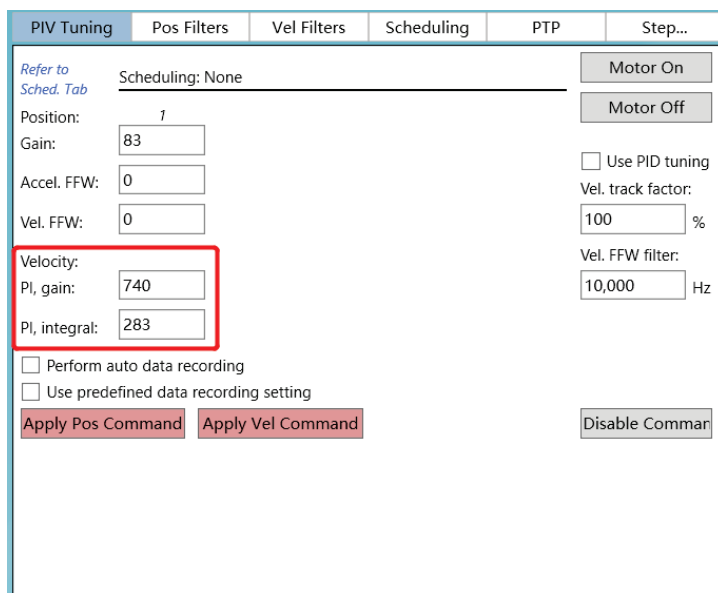
#### 4.3.4 Manual Velocity and Position Loop Tuning



Select TUNE > PIV.

Adjust the proportional (PI, gain) and integral (PI, integral) gains of velocity loop.

Click **Apply Vel Command** to check the performance.



PIV Tuning   Pos Filters   Vel Filters   Scheduling   PTP   Step...

Refer to Sched. Tab   Scheduling: None   Motor On   Motor Off

Position: 1

Gain: 83

Accel. FFW: 0

Vel. FFW: 0

Velocity:

PI, gain: 740

PI, integral: 283

☐ Use PID tuning

Vel. track factor: 100 %

Vel. FFW filter: 10,000 Hz

☐ Perform auto data recording

☐ Use predefined data recording setting

Apply Pos Command   Apply Vel Command   Disable Command

Figure 69. Manual velocity loop tuning

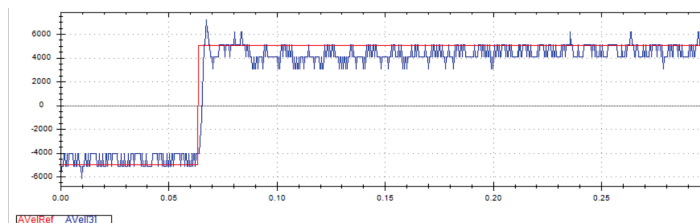


Figure 70. Typical velocity loop performance

Similarly, adjust proportional gain of position loop.

In addition, adjust acceleration and velocity feedforward to improve performance.

Click **Apply Pos Command** to check performance.

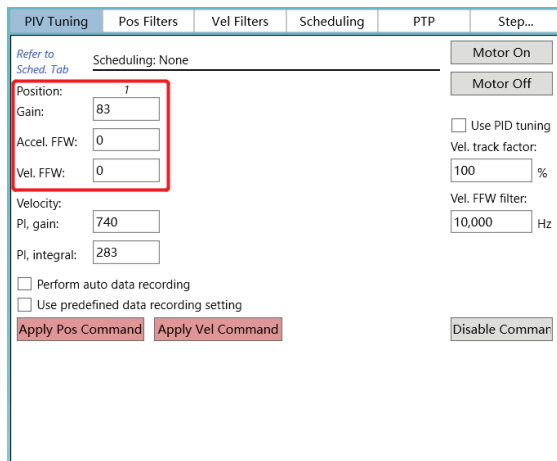


Figure 71. Position loop tuning

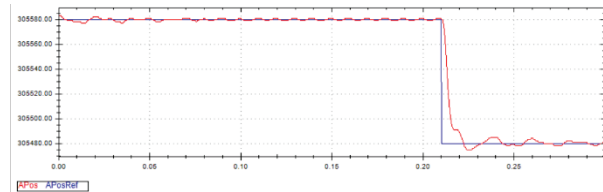


Figure 72. Typical position loop performance

Repeat the configuration and tuning steps for all the axes connected to the product.

Finally, test the motion according to the required motion profile, as shown in Figure 68. Testing motion.

## 5 Maintenance and Servicing

### 5.1 Troubleshooting

#### Troubleshooting

| Condition                                           | Potential Cause                                                                                                  | Possible Resolution                                                                                                                                                                                                                                                                                                                       |
|-----------------------------------------------------|------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Motor is oscillating or out of control (free wheel) | The position feedback sensor (encoder) is faulty or disconnected                                                 | Check wiring.                                                                                                                                                                                                                                                                                                                             |
|                                                     | Position feedback sensor is configured in wrong direction                                                        | Go to Agito PCSuite's CONFIG > FDBK page, toggle the <b>Invert direction</b> setting.                                                                                                                                                                                                                                                     |
|                                                     | Encoder signal is interfered by EMI noise in the system, resulting in lost counts or incorrect position feedback | Verify if the encoder signal is drifting even when the motor is physically locked or not moving. Check electrical grounding, shielding and PE in the system to ensure there are no ground-loop in the system.<br>Set EncFilt from Agito PCSuite's CONFIG > FDBK page to a frequency setting that is just above the required motion speed. |
|                                                     | Control loops' gains are too high                                                                                | Go to Agito PCSuite's Tune page, select CURR and/or PIV page to reduce the gains to half. If the situation improved, redo tuning for the axis.                                                                                                                                                                                            |
|                                                     | Velocity or Acceleration command is set too high                                                                 | Reduce the acceleration, deceleration, smooth and speed setting.                                                                                                                                                                                                                                                                          |
|                                                     | Noise introduced in calculation of velocity from position feedback                                               | Add a software low pass filter from Agito PCSuite's TUNE > PIV, Velocity Filters tab.                                                                                                                                                                                                                                                     |
|                                                     | Mechanical resonance.                                                                                            | Add a software low pass filter from Agito PCSuite's TUNE > PIV, Velocity Filters tab.<br>Do advanced auto tuning to allow Agito PCSuite identify and apply a suitable filter. Perform TUNE > IDEN and TUNE > DESI (Expert > Expert Tune mode for best result).                                                                            |
| Cannot achieve the required speed                   | Acceleration and/or deceleration and/or speed is set too low, or smooth is set too high.                         | Adjust acceleration, deceleration and smooth settings.                                                                                                                                                                                                                                                                                    |
|                                                     | Current and voltage limits are set too low                                                                       | Check current limits are according to motor's datasheet and maxPWM, under CONFIG->POW page, is set to between 90% and 95%.                                                                                                                                                                                                                |
|                                                     | Improper control loops gains                                                                                     | Re-tune the motor                                                                                                                                                                                                                                                                                                                         |
|                                                     | The load inertia or friction is too high for the motor                                                           | Check motor and driver sizing for this axis to ensure the motor force, current and voltage of power supply is sufficient to achieve the motion.                                                                                                                                                                                           |

| Condition                           | Potential Cause                                                                                                               | Possible Resolution                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|-------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                     | Auto-phasing is inaccurate                                                                                                    | Check that hall sensors and encoder signal are functional and not interfered by EMI in the system. And redo auto-phasing.                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Motor does not respond to a command | The axis is stopped by FLS/RLS position limit sensor or limited by software position and velocity limits.                     | Check if FLS and RLS of the motor is active. Or it could be a wrong setting where another sensor is configured wrongly as the FLS or RLS of this motor. Check software position limits and velocity limits at Agito PCSuite's CONFIG > POS page. If the FLS or RLS signal is active when the digital input is changed, the FLS or RLS status will remain ON. In this case, set the digital input to FLS or RLS, manually move the motor away from the sensor before change the digital input function. Alternatively, reset the controller or power cycle the controller. |
|                                     | The axis is configured in a wrong operating mode or function, e.g. as a slave axis or another master.                         | Check all motion related configurations.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|                                     | Motor connector is loose.                                                                                                     | Check motor power connection.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|                                     | The motor is faulty.                                                                                                          | Measure motor's resistance and inductance at Agito PCSuite's TUNE > CURR page to check if the resistance and inductance values are close to the motor specification.                                                                                                                                                                                                                                                                                                                                                                                                      |
|                                     | If this is an actuator with ballscrew, timing belt or other transmission, the coupling or other mechanical part may be loose. | Check all mechanical transmission parts and mechanism.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|                                     | Motor brake is engaged                                                                                                        | Check brake wiring and power supply.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |

