AGD155

Standalone Drive

Product Manual

Revision History		
Version	Description	Date
1.0	Initial Release	3 August 2020
1.5	Fixed typo errors, edited SOA and operating temperature range	29 December 2020
1.6	Updated Differential I/O descriptions	4 Jan 2021

Table of Content

1. General Description

1.1 Product Description

The following picture shows the AG100-DRV50D-1A-01-36 control unit, ready to connect directly to the motors.

The product is a motion control module consisting of a controller board and amplifier board integrated to a heat sink and fan, and a plastic enclosure.

It can power and control linear and rotary brushed, brushless and voice coil permanent magnet synchronous motor. It is designed for trapezoidal and sinusoidal commutation, with or without vector current control.

This product can operate in a standalone mode, controlled by a programmable stored user program, or it can be controlled by an external controller over analog, digital or communication commands.

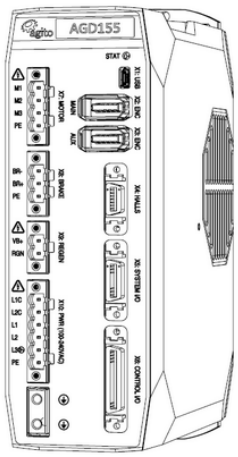


Figure 1: AGD155

1.2 Product Naming

Product description	Part numbers
Standalone Drive	AGD155-xx-2Ayy[-CCC]

xx: Feature Option

- PA: External Pulse and Direction command or +/-10V Analog Command
- AF: Full Featured model

yy: Continuous and peak current options

- 03: 3 A_{rms} continuous, 9 A_{rms} peak; 230 VAC.
- 06: 6 A_{rms} continuous, 18 A_{rms} peak; 230 VAC.
- 10: 10 A_{rms} continuous, 20 A_{rms} peak; 230 VAC.

CCC: Optional customization number

Example: **AGD155-AF-2A06**, 6 A_{rms} continuous, 18 A_{rms} peak current.

1.3 Contact information

Manufacturer	Agito Akribis Systems Ltd
Address	6 Yad-Harutsim St., P.O.Box 7172, Industrial Zone, Kfar-Saba 4464103
Telephone	+972-9-8909797
Website	www.agito.co.il

2. Safety, Warranty, Compliance and Environment

2.1 Safety

In order to achieve optimum and safe operation of the product, it is important to follow the safety procedures provided 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).

This product contains electrostatic-sensitive components, proper handling procedure 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.

Watch out for any 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.

ATTENTION: Capacitors on the DC bus can retain hazardous voltages after input power has been removed. Wait until the red LED goes off before physically touching the product. Failure to observe this precaution could result in severe bodily injury or loss of life.

ATTENTION: Do not attempt to defeat 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.

2.2 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.

2.3 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.

2.4 Environment Conditions

Condition	P/N	Units	Allowed range
Operational temperature (*)	AGD155-xx-2A03 (3 Arms continuous)	°C	0 to 50
Operational temperature (*)	AGD155-xx-2A06 (6 Arms continuous)	°C	0 to 50
Operational temperature (*)	AGD155-xx-2A10 (10 Arms continuous)	°C	0 to 40
Storage temperature	All	°C	-20 to 70
Humidity	All	%	<90

(*) note that the operational range may be additionally limited by the internal temperature protection of the product. Refer to Section 3.2.2 "Safe Operating Area".

2.5 Copyrights and Trademarks

2.5.1 Copyright Notice

2.5.2 Products Rights

AGDx, AGCx, AGMx, AGAx, AGIx and AGLx are products designed by Agito Akribis Systems Ltd in Israel. Sales of the products are licensed to Akribis Systems Pte Ltd under intercompany license agreement.

Agito Akribis Systems Ltd have full rights to distribute above products worldwide.

2.5.3 Disclaimer

This product documentation was accurate and reliable at the time of its release.

Agito Akribis Motion Systems Ltd reserves the right to change the specifications of the product described in this manual without notice at any time.

2.5.4 Trademarks

PCSuite is trademark of Agito Akribis Motion Systems Ltd.

3. Installation Instruction

3.1 Mechanical Dimensions and Mounting

User can mount the AGD155 with 2 screws, according to the picture below. For vertical mounting, the closed hole should be mounted on top while the open, slotted hole at the bottom. It is important to securely mount the base plate on the electrical panel to avoid vibration and loosening of the connectors. The base plate is electrically conductive and serve as the protective earth (PE) ground of the product. However, it is critical to ensure the PE screws (at the top left corner in the picture below) are electrically conducting between the PE of AGD155 and the PE of main power supply in the system. 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.

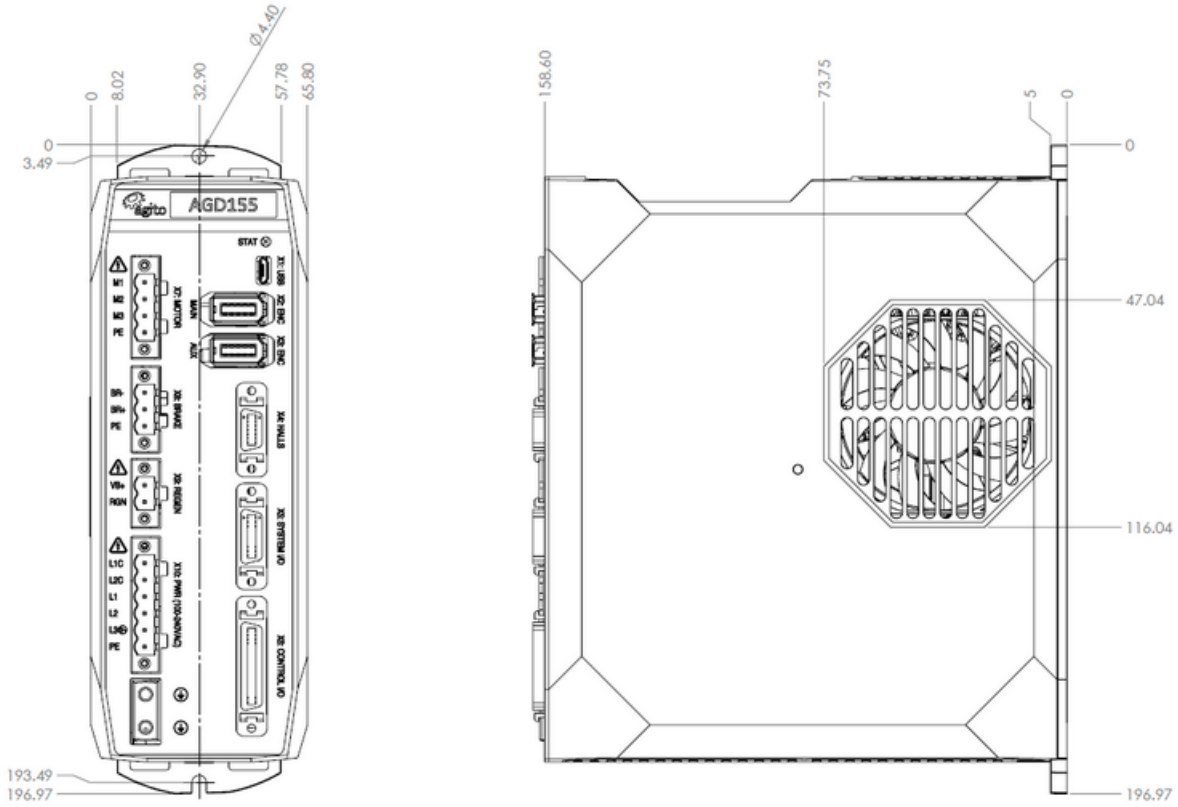


Figure 2: Mechanical mounting dimensions

Warning – Metal Base Plate for Heat Dissipation!

The product is supplied with a metal base, for protection and firm mounting, as well as for heat dissipation. At full power operation, the base plate can be quite warm, around 45 degree Celsius, it is recommended to mount the product on a big metal plate to help dissipating the heat generated in the product.

3.2 Power Rating, Safe Operating Area and Grounding Policy

3.2.1 Power Rating

The following table presents the absolute maximal power, voltage, current and temperature ratings of the product.

Operating (or storing) the product outside of the above defined Absolute Maximal Ratings are not allowed and will damage the product.

Each of the power/voltage/current Absolute Maximal Ratings is valid over the overall operating temperature range, subjected to the SOA (Safe Operating Area) as defined below.

S/N	Description	Units	Maximum Ratings	Remark
1	Continuous motor current	A_{rms}	Up to 10	Internally limited by FW (variant dependent, see Section 1.2)
2	Peak motor current	A_{rms}	Up to 20	Internally limited by FW (variant dependent, see Section 1.2)
3	Main power supply	VAC	240	See Note 1.
4	Current per 5V pin	A	0.5	To external components. Internally limited by HW
4	Overall 5V current	A	1.5	To external components. See Note 2.
5	Isolated output, sink	A	0.5	Per output. See Note 3.
6	Isolated output, source	A	0.3	Per output. See Note 3.
7	Isolated input	V	28	See Note 4.
8	Common power/GND to isolated I/O's	A	1	Per connector. See Note 4.
9	I/O power input current	A	4.5	Current at I/O power connector. See Note 4.
10	Operating temperature	°C	0 – 50	See Note 5.
11	Storage temperature	°C	-20 – 70	Below 40% relative humidity

Notes:

1. While VBus is monitored and motors will be disabled in case of too high voltage, there is no protection against connection of too high voltage power supply. Such connection will damage the product.
2. While each 5V pin is limited to supply up to 0.5A, there is no protection to limit the overall current of 5V to external devices to this limit. Sourcing more than this limit may result with unexpected wrong behavior of the product.
3. This limit has no internal protection! Sinking (or sourcing, as relevant) values higher than this limit will damage the product.
4. This limit has no internal protection! Exceeding this limit will damage the product.
5. The product includes a built-in temperature protection, as described below. However, it is the user's responsibility not to operate the product, at any circumstances and conditions, with environmental conditions outside the defined limits.

3.2.2 Safe Operating Area

While each specific maximal rating can be safely used, the product will not be able to provide some combinations of these maximal ratings.

For example, the product will not enable operation under the following combined maximal ratings usage continuously over long-term period:

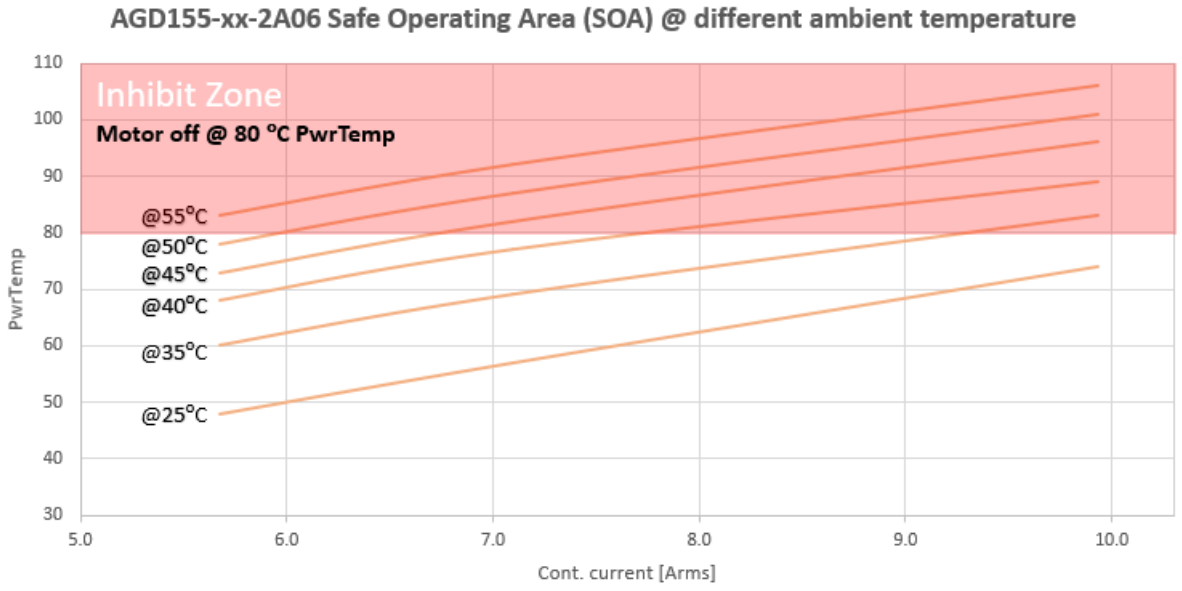
i. Continuous current at $6A_{rms}$, at 90% PWM duty cycle, and
ii. 1.5A external load on the 5V supply, and
iii. Product mounted horizontally and is not attached to a suitable base plate, and
iv. 55°C ambient temperature.

The allowed combinations (as well as the unallowed combinations) can't be specifically provided since they are a function of multiple conditions such as: continuous current, bus voltage, PWM duty cycle, 5V consumption, I/O's high current usage, mounting base plate size, product mounting orientation and ambient temperature.

The SOA of the product is defined as any combination of operational conditions (each within the Absolute Maximal Ratings defined in Section 3.2.1) and assembly options that lead to internal product temperature below 80 °C.

The product includes a built-in temperature sensor. Its internal temperature is reported via the status parameter PwrTemp (integrated power module temperature). When PwrTemp reaches 80 °C, motor will be disabled with a proper error message. Motor-enable request will create an error if PwrTemp is higher than 80 °C.

Below are some examples of safe operating cases for AGD155-AF-2A06. The SOA charts assume 90% duty cycle on PWM output continuously, i.e. motors are moving at the maximum speed allowed by the bus voltage.



3.2.3 Grounding Policy

This section describes some common ground policy for both DC and AC products. However, every system is unique and may requires different grounding policy.

3.2.3.1 Overview

There are few common ground domains in the systems:

- GND (reference voltage for digital/analog circuits and signals)
- PGND (reference voltage for motor/regeneration circuits)
- General – will usually be at DC potential close to GND, but not connected internally

There are few common interfaces between all Agito's products, presented in the table below.

S/N	Name	Ground Domain	Isolation
1	DC power input	GND (digital ground)	
2	AC power input	PGND (power ground only)	
3	Ethernet communication	General	Isolated
4	Other communication	GND	Not isolated (unless otherwise stated in manual)
4	Central-i communication Not relevant	GND (for Master)	Isolated for Central-i remote devices
5	Isolated digital inputs/outputs	General	Isolated
6	Differential inputs/outputs (not isolated)	GND	Not isolated
7	Analog inputs/outputs (not isolated)	GND	Not isolated
8	Brake control output	General	Isolated
9	Regeneration output	PGND, GND	Always referenced to PGND, in AC products isolated from GND

3.2.3.2 Policy

The policy below is based on the following guidelines:

- In all products, the enclosures and other external parts that may be touched by the user are in "safe domain".

  Most will be designated Protective Earth (PE) and connected to building's Ground. PE is protected with Earth-leakage circuit breaker (ELCB), hence is safe to touch.

  Others may be GND or signals, with voltage within few tens of volts above GND, hence safe.

- Exception: power inputs, motor connectors, regeneration outputs all are not safe to touch and may be exposed, if the connector is not populated!
- GND, the digital ground, is assumed to have same potential (at least in DC) as the PE. That means, at some point in the system GND is connected to the PE.

In DC devices, unless otherwise stated in the manual, the GND is not connected to PE inside the product. The user must consider the system design and decide about where to connect them.

The common recommendation is to connect PE to GND on the DC power supply.

In AC devices, since the DC supply is isolated and internal, GND is connected at a single point to the PE inside the product.

- In AC products PGND is (almost) directly connected to mains wires, hence is just as dangerous, as mains, for the user.
- All shielded cables, including but not limited to motor, encoders, power input, have their shield connected to PE as part of external metal enclosure.
- GND (digital ground) is bypassed to PE with high capacitance (10µF and more) for EMI/EMC purposes.
- PGND is bypassed to PE with low capacitance (around 10nF) for EMI/EMC purposes.
- It is very important to avoid ground loops in the system. Ground loop allows currents to return by two or more different paths, causing electromagnetic interference or even damage to wires.

  The most susceptible point is GND, as most control and communication signals are referenced to it, requiring GND wires in many different cables.
- System designer must carefully examine all GND connections in system to ensure no loops are created on one hand, and all GND-referenced signals have GND wire nearby (for both return currents and common mode voltage).

3.3 Electrical Interface

This section provides a detailed description of all the power and signal interfaces of the product.

3.3.1 Power connectors

This section describes all power connectors in the product.

3.3.1.1 X10: Power

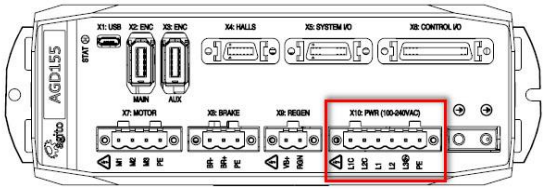


Figure 3: Power Connector

Connector X10: PWR

Pin #	Name	Description
1	L1C	AC Logic power
2	L2C	AC Logic power
3	L1	AC Main power
4	L2	AC Main power
5	L3 (3-phase)	AC Main power for 3-phase power input
6	PE	Protective Earth

Connector Manufacturer: Phoenix Contact
Mating Connector Part number: 1942523
(Wurth Electronics equivalent: 691359740006)
(Degson equivalent: 2EDGKDM-5.08-6P-14)
Connector Pitch: 5.08 mm

Connect L1, L2 and L3 for main bus power.
If the main voltage is from a single-phase source, connect line and neutral to L1 and L2.
If the main voltage is from a three-phase source, connect the phase to L1, L2 and L3.

Connect line and neutral to L1C and L2C for logic power.

Hot plugging is not supported! Plug or unplug the power connector only when power is off and after bus LED is turned off (red LED visible at the side of the product)! Plugging the power connector when it has power can lead to undesired high current through devices that are connected to the controller and damage these devices.

3.3.1.2 X14: I/O and Brake Power

This connector allows user to provide DC power supply to the isolated I/Os and motor brake. Typically, the isolated I/Os are using 24VDC. The I/O power is internal connected to each I/O port to allow user to tap this power supply easily within the same connector.

The brake power support up to 48VDC. This power is internally connected to the brake output port

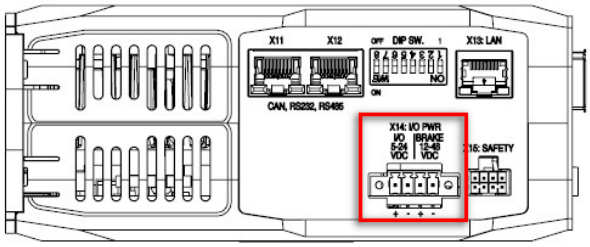


Figure 4: I/O and Brake Power Connector

Connector X14: I/O PWR

Pin #	Name	Description
1	IO_PWR	5 to 24 VDC – User supplied I/O Power Input, up to 2A
2	IO_PWR_Return	Gnd – I/O Power Return
3	VBrake	12 to 48 VDC – Brake Power Input, up to 70W
4	VBrake_Return	Gnd – Brake Power Return

Connector Manufacturer: Phoenix Contact
Mating Connector Part number: 1966114
(Wurth Electronics equivalent: 691364100004)
(Degson equivalent: 15EDGKDM-3.5-04P-14)
Connector Pitch: 3.5 mm

Warning - Hot plugging is not allowed!

Plug in or unplug the power connector only when power is off! Plugging the power connector with power ON can lead to undesired high current passing through ALL devices that are connected to the product's Gnd and damaging these devices.

3.3.2 Communication Ports

The section describes all the communication ports available for the host computer or controller to communicate with the product. User can refer to the Communication Protocol Manual for the software details of the communication and a separate Command and Reference Manual for all the supported keywords and parameters.

3.3.2.1 X13: Ethernet

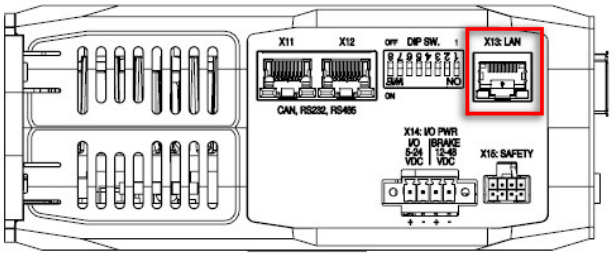


Figure 5: Ethernet Connector

Description: RJ45 LAN 10/100Base-T Connector with magnetic
Cable: CAT5e or higher, standard Ethernet straight cable

Connector X13: LAN (Ethernet)

Pin #	Name	Description
1	TX+_D1	Transmit Data+
2	TX-_D1	Transmit Data-
3	RX+_D2	Receive Data+
4	BI+_D3	Bi-directional+
5	BI-_D3	Bi-directional+
6	RX-_D2	Receive Data-
7	BI+_D4	Bi-directional+
8	BI-_D4	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

3.3.2.2 X11, X12: CAN Bus, RS-232 and RS-485 (serial communication port)

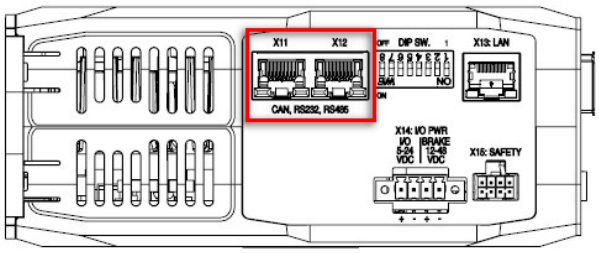


Figure 6: Serial Communication Connectors

Connector X11 and X12: CAN, RS232, RS485

Pin #	Name	Description
1	GND	Digital Ground
2	RS232_RX	RS232 input (receive at product)
3	RS232_TX	RS232 output (transmit from product)
4	RS485_B	RS-485 bus, inverted
5	RS485_A	RS-485 bus, not inverted
6	Sync	Reserved for future use
7	CAN_L	CAN bus, Low
8	CAN_H	CAN bus, High

Connector Type: Standard RJ45, shielded

Note – Why dual port connector?

The serial port is a dual-port RJ45 connector. The two ports have identical pinout and are interchangeable. Two ports are provided to support daisy chain connection of CAN Bus or RS-485. It can be also used to connect two types of communication channels at the same time, instead of splitting a cable from a single RJ45 connector.

Note – CAN Bus and RS-485 terminators.

The CAN Bus lines have optional 120 ohms terminator that is connected/disconnected by DIP Switch (“DIP SW.”, beside the serial port) number 1. Set “DIP SW.” number 1 to ON position will connect a 120 ohms terminator between CAN_H and CAN_L (this is needed only at the last unit in the CAN bus chain).

The RS-485 lines have a built-in (not optional) 120 ohms terminator. This may degrade the communication performance in case too many units are placed on the RS-485 chain.

3.3.2.3 X1: Micro USB

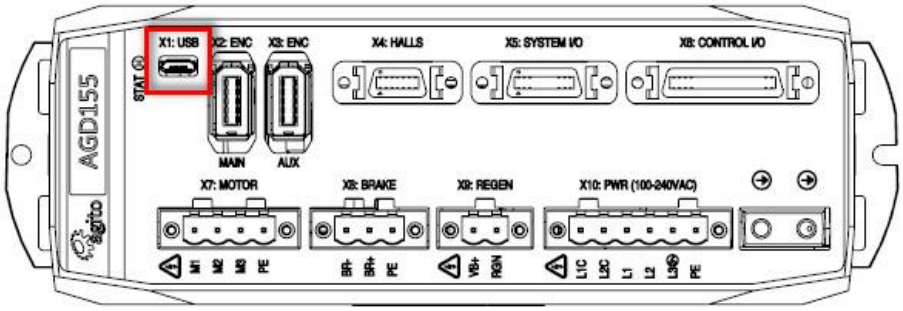


Figure 7: USB Connector

Connector X1: USB

Pin #	Name	Description
1	Vcc	5V
2	D-	Data-
3	D+	Data+
4	ID	USB OTG ID
5	GND	GND

Connector Description: Micro-USB 2.0 B-Type
Mating Connector Part number: Any Micro-USB 2.0 B-Type cable

Note – USB to RS232 Bridge.

The Micro USB connection is implemented using an internal bridge from USB to RS-232 (UART). As a result, the communication performance, from user's perspective, is identical to RS-232, using a suitable software driver at the PC side.

For PC Software drivers, although in most cases they are automatically loaded, you may visit the link for the files if required: http://www.ftdichip.com/Drivers/D2XX.htm.

3.3.3 Axis Interfaces

3.3.3.1 X2: Main Encoder

X2 port is designed to interface with the main (primary position feedback) encoder for the axis. This port can input digital quadrature incremental encoder (AquadB), analog SinCos incremental encoder, absolute BiSS-C encoder or absolute EnDat2.2 encoder.

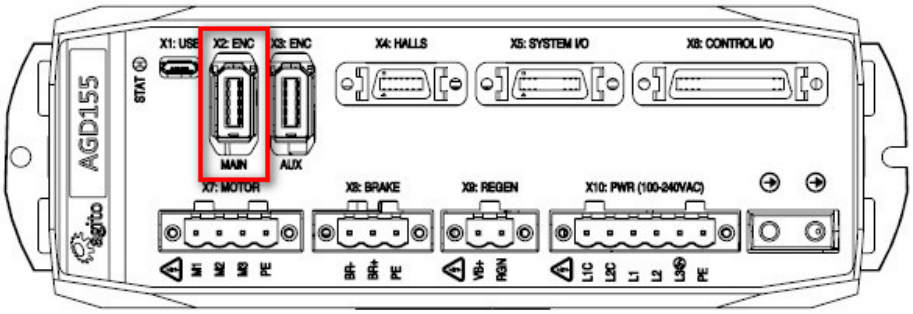


Figure 8: Main Encoder Connector

Connector X2: ENC (MAIN)

Pin #	Name	Encoder Types				Description
		AqB	Sin/Cos	Biss-C	Endat2.2	
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: 3M
Mating Connector Part number: 36210-0100PL + 36310-3200-008
(Sunchu equivalent: SC-10-4P)

Note – Incremental encoder interface details.

Each differential-pair includes a built-in 120 ohms terminator and the required hardware circuits to detect disconnected encoder cable. When 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 or Z-channel). The product does not support single-ended encoder by default.

Note – 5V supply limitation.

The 5V supply provided at pin 1 of each ENC connector is internally limited to 0.6 A.

3.3.3.2 X3: Auxiliary Encoder

X3 is designed to interface with an auxiliary (second) encoder for the axis. It is similar to the main encoder port, supporting digital quadrature incremental encoder, absolute BiSS-C and absolute EnDat2.2 encoder, but it does not support analog SinCos encoder input.

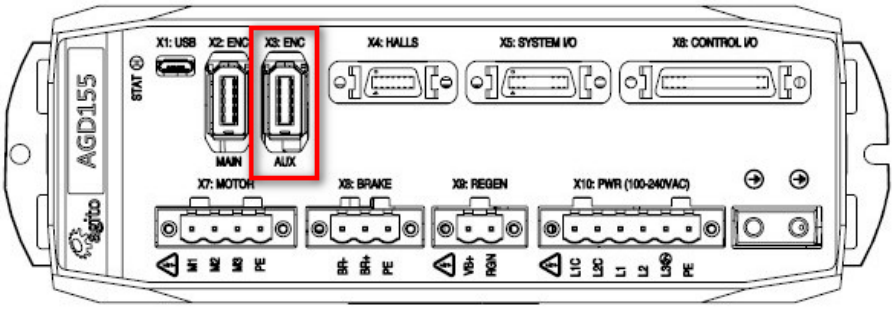


Figure 9 Aux Encoder Connector

Connector X3: ENC (AUX)

Pin #	Name	Encoder Types			Description
		AqB	Biss-C	Endat2.2	
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+			A+ (for AqB)
6	Encoder_2-	A-			A- (for AqB)
7	Encoder_3+	B+			B+ (for AqB)
8	Encoder_3-	B-			B- (for AqB)
9	Encoder_4+	Z+	DATA+	DATA+	Data+ for absolute encoders or Z+ for AqB
10	Encoder_4-	Z-	DATA-	DATA-	Data- for absolute encoders or Z- for AqB

Connector Manufacturer: 3M
Mating Connector Part number: 36210-0100PL + 36310-3200-008
(Sunchu equivalent: SC-10-4P)

Note – Incremental encoder interface details.

Each differential-pair includes a built-in 120 ohms terminator and the required hardware circuits to detect disconnected encoder cable. When 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 or Z-channel). The product does not support single-ended encoder by default.

Note – 5V supply limitation.

The 5V supply provided at pin 1 of each ENC connector is internally limited to 0.6 A.

3.3.3.3 X4: Halls

The HALLS connector interfaces with the digital hall effect sensors and PT100 temperature sensor from the motor.

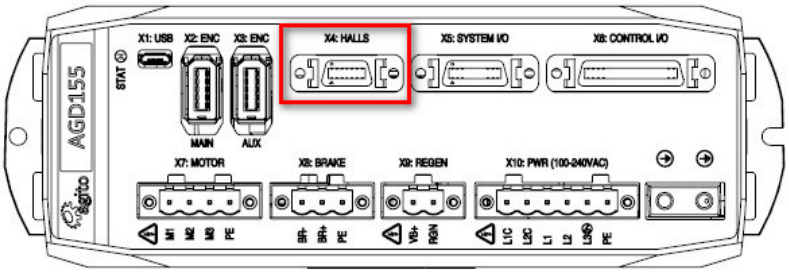


Figure 10: Hall Sensors Connector

Connector X4: HALLS

Pin #	Name	Software Representation	Description
1	5V		5V supply to Hall sensors; Connect to Pin 10 when using Digital Input 1 to 3 for Hall sensors.
2	GND		GND for 5V
3			
4	Digital_Input_1 (Hall_A)	DInPort.Bit(0)	Isolated Digital Input 1 (NPN or PNP, depending on connection of the common pin of this group). To use as Hall input, configure at PCSuite Digital Input page as Hall A
5	Digital_Input_2 (Hall_B)	DInPort.Bit(1)	Isolated Digital Input 2 (NPN or PNP, depending on connection of the common pin of this group)
6			
7	PE		PE
8	RTD+		PT100+ (or PT1000+ if Pin 3 is shorted to Pin 6)
9	RTD-		PT100- (or PT1000- if Pin 3 is shorted to Pin 6)
10	Digital_Input_Common (1 to 3)		Common pin (power or return, depending on external connection) for digital input 1 to 3
11	Digital_Input_3 (Hall_C)	DInPort.Bit(2)	Isolated Digital Input 3 (NPN or PNP, depending on connection of the common pin of this group)
12	Digital_Input_4	DInPort.Bit(3)	Isolated Digital Input 4, PNP only. For thermostat input, one end connected to IO_PWR, the other end connected here
13	IO_PWR		Internally connect to connector X14: I/O PWR pin 1
14	IO_PWR_Return		Internally connect to connector X14: I/O PWR pin 2

Connector Manufacturer: 3M
Mating Connector Part number: 10114-3000PE + 10314-52A0-008
(Sunchu equivalent: SC-14-3)

Note – 5V supply limitation.

The 5V supply provided at pin 1 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.

3.3.3.4 X5: System I/O

Connector X5: SYSTEM I/O

Pin #	Name	Software Representation	Description
1	Digital_Input_5	DInPort.Bit(4)	Isolated Digital Input 5 (NPN or PNP, depending on connection of the common pin of this group)
2	Digital_Input_7	DInPort.Bit(6)	Isolated Digital Input 7 (NPN or PNP, depending on connection of the common pin of this group)
3	Digital_Input_9	DInPort.Bit(8)	Isolated Digital Input 9 (NPN or PNP, depending on connection of the common pin of this group)
4	Digital_Output_1	DOutPort.Bit(0)	Isolated Digital Output 1, programmable sink or source
5	Digital_Output_2	DOutPort.Bit(1)	Isolated Digital Output 2, programmable sink or source
6	Analog_Input_1	AInPort[1]	Analog Input 1, +/-12V full scale
7	Analog_Input_Return_1		
8	Bi-Dir_Diff_IO_1+	DInPort.bit(19) DOutPort.bit(10)	Bi-Directional Differential I/O+ BiDirConfig.bit0 = 0 for Input BiDirConfig.bit0 = 1 for Output
9	Bi-Dir_Diff_IO_1-		Bi-Directional Differential I/O- BiDirConfig.bit0 = 0 for Input BiDirConfig.bit0 = 1 for Output
10	GND		GND for Analog Output
11	Digital_Input_Common (5 to 9)		Common pin (power or return, depending on external connection) for digital input 5 to 9
12	Digital_Input_6	DInPort.Bit(5)	Isolated Digital Input 6 (NPN or PNP, depending on connection of the common pin of this group)
13	Digital_Input_8	DInPort.Bit(7)	Isolated Digital Input 8 (NPN or PNP, depending on connection of the common pin of this group)
14	Digital_Output_Common_Power (1 to 2)		Common power pin for isolated digital outputs 1 to 2
15	Digital_Output_Common_Return (1 to 2)		Common power return pin for isolated digital outputs 1 to 2
16	Analog_Output_1	AOutPort [1]	Analog Output 1, +/-12V full scale
17	Analog_Output_2	AOutPort [2]	Analog Output 2, +/-12V full scale
18	GND		GND for Analog Output
19	IO_PWR		Internally connect to connector X14: I/O PWR pin 1
20	IO_PWR_Return		Internally connect to connector X14: I/O PWR pin 2

Connector Manufacturer: 3M
Mating Connector Part number: 10120-3000PE + 10320-52A0-008
(Sunchu equivalent: SC-20-3)

Note – Not all product variants provide Analog I/Os.

Not all product variants provide Analog Input and/or Analog Outputs. Analog I/O resolution is also variant-dependent. Refer to product catalog to order the right variant.

Analog outputs are required to interface external driver/amplifier as ±10V analog command. They can also be used as general-purpose analog I/Os.

3.3.3.5 X6: Control I/O

The Control I/O port includes typical set of I/Os (digital isolated, fast differential and analog) for operation with an external controller via +/-10V analog command or digital Pulse and Direction command.

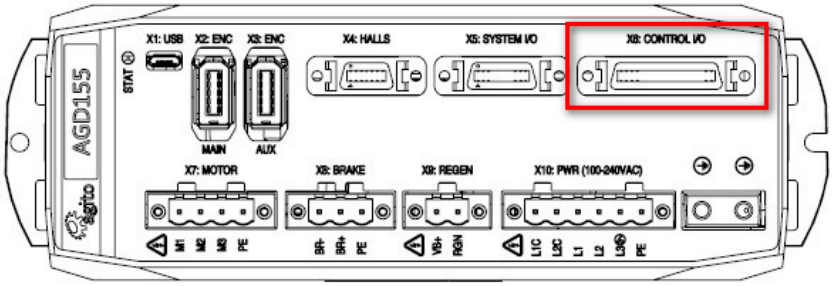


Figure 11: Control I/O Connector

Connector X6: CONTROL I/O

Pin #	Name	Software Representation	Description
1	Differential_Output_1+	DOutPort.Bit(6)	Differential Output 1+; Emulated Encoder A+
2	Differential_Output_1-		Differential Output 1-; Emulated Encoder A-
3	Differential_Output_3+	DOutPort.Bit(8)	Differential Output 3+; Emulated Encoder Z+
4	Differential_Output_3-		Differential Output 3-; Emulated Encoder Z-
5	GND		GND for the differential I/Os
6	Analog_Input_2	AInPort[2]	Discrete, isolated, Abort input, pin 1
7	Analog_Input_Return_2		Discrete, isolated, Abort input, pin 2
8	Differential_Input_2+	DInPort.Bit(17)	Differential Input 2+; P&D Direction Input
9	Differential_Input_2-		Differential Input 2-; P&D Direction Input
10	GND		GND for the differential I/Os
11	Digital_Input_10	DInPort.Bit(9)	Isolated Digital Input 10 (NPN or PNP, depending on connection of the common pin of this group)
12	Digital_Input_12	DInPort.Bit(11)	Isolated Digital Input 12 (NPN or PNP, depending on connection of the common pin of this group)
13	Digital_Input_14	DInPort.Bit(13)	Isolated Digital Input 14 (NPN or PNP, depending on connection of the common pin of this group)
14	Digital_Input_16	DInPort.Bit(15)	Isolated Digital Input 16 (NPN or PNP, depending on connection of the common pin of this group)
15	Digital_Output_3	DOutPort.Bit(2)	Isolated Digital Output 3, programmable sink or source
16	Digital_Output_Common_Power (3 to 6)		Common power pin for isolated digital outputs 3 to 6
17	Digital_Output_Common_Return (3 to 6)		Common power return pin for isolated digital outputs 3 to 6

Pin #	Name	Software Representation	Description
18	GND		GND for the differential I/Os
19	Differential_Output_2+	DOutPort.Bit(7)	Differential Output 2+; Emulated Encoder B+
20	Differential_Output_2-		Differential Output 2-; Emulated Encoder B-
21	Differential_Output_4+	DOutPort.Bit(9)	Differential Output 4+
22	Differential_Output_4-		Differential Output 4-
23	GND		GND for the differential I/Os
24	Differential_Input_1+	DInPort.Bit(16)	Differential Input 1+; P&D Pulse Input
25	Differential_Input_1-		Differential Input 1-; P&D Pulse Input
26	Differential_Input_3+	DInPort.Bit(18)	Differential Input 3+
27	Differential_Input_3-		Differential Input 3-
28	GND		GND for the differential I/Os
29	Digital_Input_Common (10 to 16)		Common pin (power or return, depending on external connection) for digital input 10 to 16
30	Digital_Input_11	DInPort.Bit(10)	Isolated Digital Input 11 (NPN or PNP, depending on connection of the common pin of this group)
31	Digital_Input_13	DInPort.Bit(12)	Isolated Digital Input 13 (NPN or PNP, depending on connection of the common pin of this group)
32	Digital_Input_15	DInPort.Bit(14)	Isolated Digital Input 15 (NPN or PNP, depending on connection of the common pin of this group)
33	Digital_Output_4	DOutPort.Bit(3)	Isolated Digital Output 4, programmable sink or source
34	Digital_Output_5	DOutPort.Bit(4)	Isolated Digital Output 5, programmable sink or source
35	Digital_Output_6	DOutPort.Bit(5)	Isolated Digital Output 6, programmable sink or source
36	5V		5V output

Connector Manufacturer: 3M
Mating Connector Part number: 10136-3000PE + 10336-52A0-008
(Sunchu equivalent: SC-36-3)

Note – Not all product variants provide Analog I/Os.

Not all product variants provide Analog Input and/or Analog Outputs.

Analog outputs are required to interface external driver/amplifier as ±10V analog command. They can also be used as general-purpose analog I/Os.

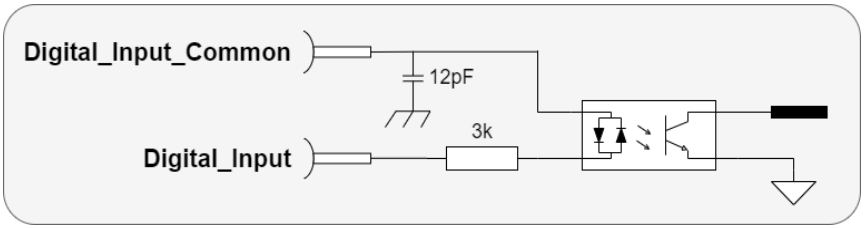
Note – 5V Common_Power source mode limitation.

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

3.3.3.6 Electrical Schematics for I/O connections

The section describes the electrical I/O interfaces that are related to external devices. The number of I/Os available in the product depends on the model number or variant number. Please refer to product catalog or consult your sales channel for more details.

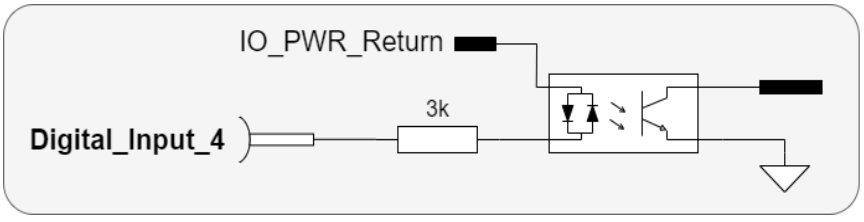
Electrical interfaces – Digital Input 1 to 3, 5 to 9 and 10 to 16 (3 isolated groups):



Notes:

- The interface circuit is identical for all 16 digital inputs, except Digital_Input_4 (refer to the electrical interface of Digital_Input_4).
- Digital_Input_Common are grouped by Digital Input 1 to 3, 5 to 9, and 10 to 16. Digital_Input_4 is not part of these groups.
- 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 Digital_Input_Common pin. If the Digital_Input_Common pin is connected to power (between 5V and 24V), then the inputs of this group can be used with external NPN devices (external current sinking devices). If the Digital_Input_Common is connected to the GND of some external power, then the inputs of this group can be used with external PNP devices (external current sourcing devices).
- Note that the input circuit of the opto-couplers includes two diodes. This enables the usage 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 Digital_Input_Common pin.

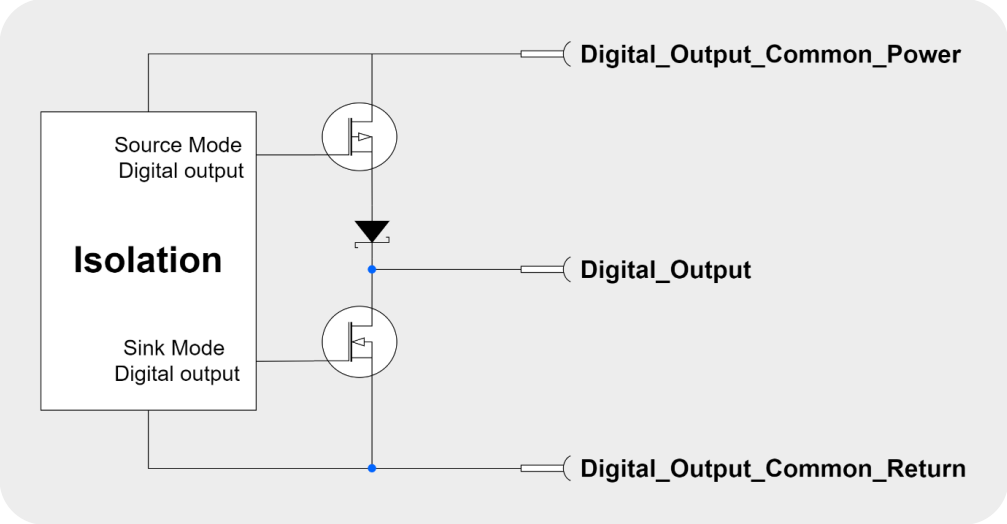
Electrical interfaces –Digital Input 4:



Notes:

- Digital_Input_4 is internally pulled to IO_PWR_Return, it can only be connected as sinking input.

Electrical interfaces – Digital Output 1 to 2, and 3 to 6 (2 isolated groups):



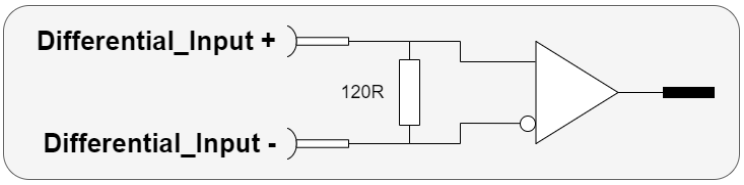
Notes:

- The interface circuit is identical for all outputs.
- Each output can be programmed (by software parameter) to act as a current sourcing output (up to 300mA) or as a current sinking output (up to 500mA).
- Digital_Output_Common_Power is organized into 2 groups, Digital Output 1 to 2, and Digital Output 3 to 6.
- The outputs are designed for resistive loads. For inductive loads, an external flyback diode is required.
- Discrete outputs specifications:
  - ❖ Digital_Output_Common_Power voltage range is between 5V and 24V.
  - ❖ Maximal load current, per each output:
    a. SINK mode, any Digital_Output_Common_Power voltage: 500mA
    b. SOURCE mode, at 24V Digital_Output_Common_Power: 300mA
    c. SOURCE mode, at 5V Digital_Output_Common_Power: 60mA (**see note below**)

Note – 5V Digital_Output_Common_Power source mode limitation.

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

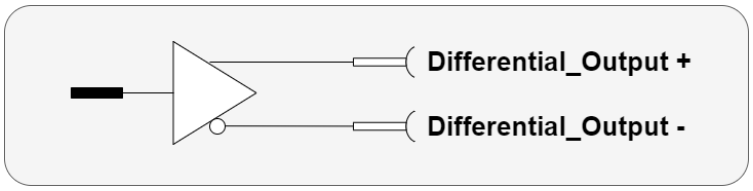
Electrical interfaces – Differential input 1 to 3:



Notes:

- Note that each differential input has 120 ohms terminator.
- Note that each differential input has pull-up to 3.3V on its positive pin and pull down to GND on its negative pin. This ensures that the input is not floating when not connected and that its reading is known and fixed.
- Note that the negative input pin, on each differential input, has also a pull-up to 3.3V. This enables the usage of a differential input with a single-ended source, by connecting it to the positive input only and leaving the negative pin disconnected.
- The differential inputs can be used with 5V differential sources.

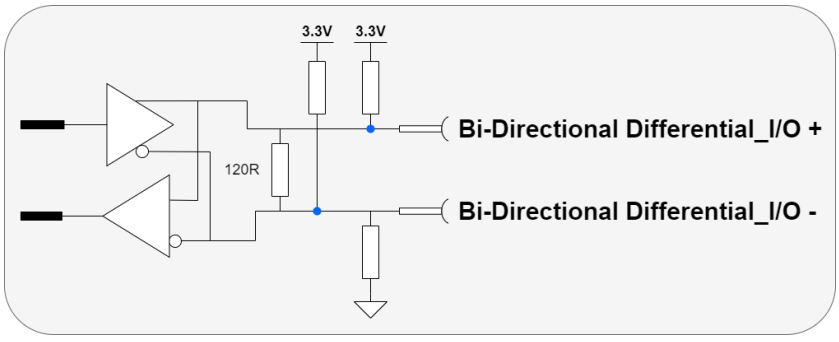
Electrical interfaces – Differential Output 1 to 4:



Notes:

- The differential outputs are disabled immediately after power on, until they are controlled by the software and the user defined parameters.

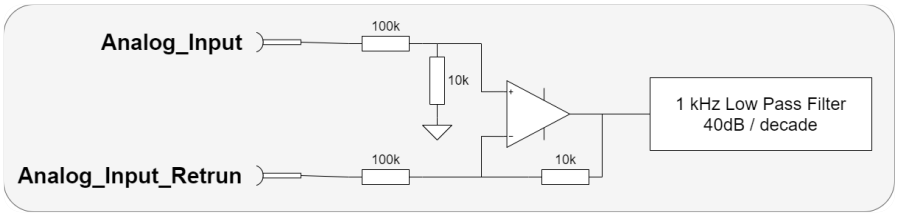
Electrical interfaces – Bi-Directional Differential I/O:



Notes:

- The Bi-Directional Differential Output is configurable by software to be differential output or differential input.
- Note that both + and - pins are pulled up to 3.3V.
- Note that there is a 120 ohms termination resistor between the + and - pins.

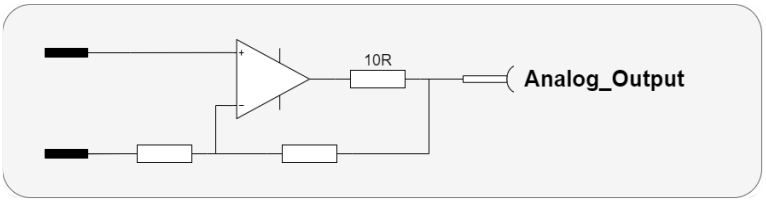
Electrical interfaces – Analog Input 1 to 2:



Notes:

- The electrical interfaces of all analog inputs are identical.
- The analog inputs' range is -12V to +12V, resolution is 14 or 16 bits (variant dependent).
- The analog inputs are designed for standard differential analog input, with a simple input circuit, having an input resistance of ~60K ohms.
- For single-ended analog inputs, take care to connect the return line to GND. Do not leave it unconnected.
- Input circuit bandwidth is 1KHz, -40 dB/decade.
- The controller software provides parameters below to control the analog input reading:
  - ❖ Filter
  - ❖ Offset
  - ❖ Dead band
  - ❖ Gain

Electrical interfaces – Analog Output 1 to 2:



Notes:

- Some product variants do not come with analog output.
- The electrical interfaces of all analog outputs are identical.
- The analog outputs' range is from -12V to +12V, resolution is 16 bits.
- Output resistance is 10ohms.
- Output current is up to ±2mA, without internal current limitation.
- Analog outputs are controlled by the controller software in few operational modes:
  - ❖ Analog command to external amplifier.
  - ❖ Analog output controlled by the user for any generic purpose.
  - ❖ Analog output reflects the internal value of a user selected parameter (position, position error, velocity, current or any parameter/status of the controller), with a user defined scaling factor, for easy monitoring using an external oscilloscope.

3.3.3.7 X7: Motor

The motor port supply power to the motor, which can be a 3-phase brushless motor or a single-phase brushed motor or voice coil motor.

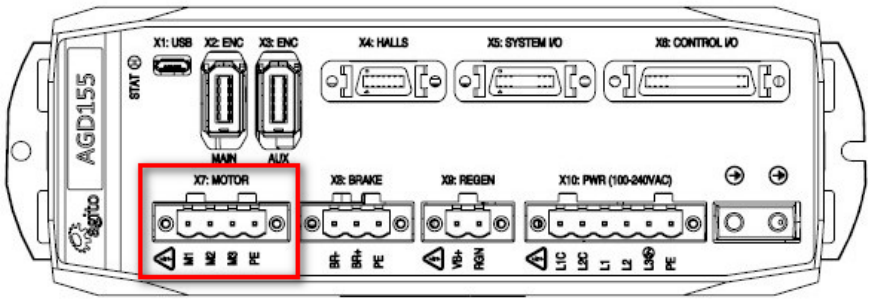


Figure 12 Motor Connector

For Brushless motor:

Connector X7: MOTOR (Brushless Motor)

Pin #	Name	Description
1	Phase A	Motor's Phase A, or M1
2	Phase B	Motor's Phase B, or M2
3	Phase C	Motor's Phase C, or M3
4	PE	Protective Earth (Motor Power Cable Shield)

Connector Manufacturer: Phoenix Contact
Mating Connector Part number: 1942507
(Wurth Electronics equivalent: 691340500004)
(Degson equivalent: 2EDGKDM-5.08-4P-14)
Connector Pitch: 5.08mm

For Brush (or voice coil) motor:

Connector X7: MOTOR (Brushed or Voice Coil Motor)

Pin #	Name	Description
1	Motor Phase +	Positive Terminal, Phase A or M1
2	Motor Phase -	Negative Terminal, Phase B or M2
3	NC	Do not connect
4	PE	Protective Earth (Motor Power Cable Shield)

Connector Manufacturer: Phoenix Contact
Mating Connector Part number: 1942507
(Wurth Electronics equivalent: 691340500004)
(Degson equivalent: 2EDGKDM-5.08-4P-14)
Connector Pitch: 5.08mm

3.3.3.8 X8: Static Brake

Some motors come with a static brake, which is engaged when the motor is not enabled. The Brake port provides the interface to connect this static brake.

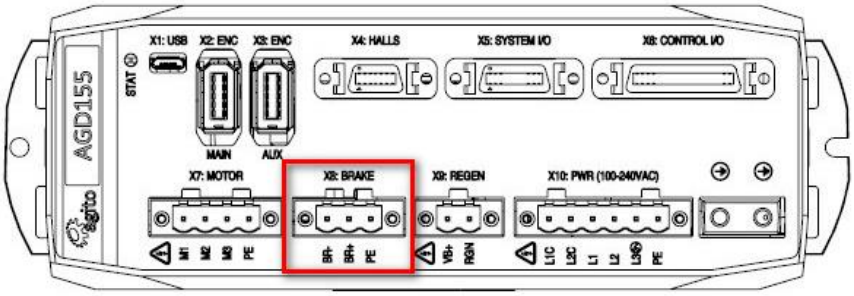


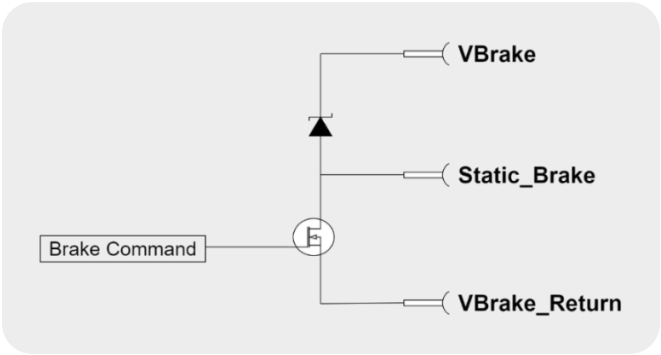
Figure 13 Brake Connector

Connector X8: BRAKE

Pin #	Name	Description
1	BR- (Static_Brake)	Static brake output for motor A. Open-drain output with built-in flyback diode to the VBrake for direct connection into inductive load
2	BR+ (VBrake)	Power out to Brake (internally connected to X14: I/O PWR Pin-3, VBrake)
3	PE	Protective Earth

Connector Manufacturer: Phoenix Contact
Mating Connector Part number: 1942497
(Wurth Electronics equivalent: 691340500003)
(Degson equivalent: 2EDGKDM-5.08-3P-14)
Connector Pitch: 5.08mm

Electrical interfaces – static brakes:



3.3.4 System Interfaces

This section provides information about system interfaces like regeneration, safety and DIP switches.

3.3.4.1 X9: Regeneration

The Regeneration port 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 above the operating limit of the product, it will trigger an over-voltage protection and disable the motor. To avoid this from happening, user can connect an external power resistor to dissipate the unwanted energy.

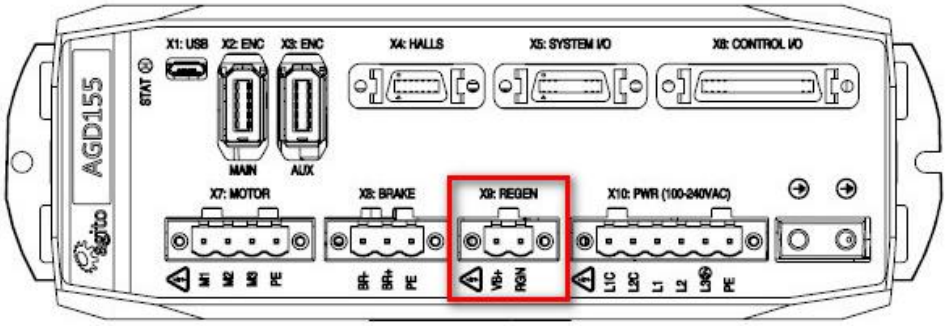


Figure 14 Regeneration Connector

Connector X9: REGEN

Pin #	Name	Description
1	VB+	The internal DC Bus power. (Warning: This is typically more than 300VDC)
2	RGN (Regeneration)	Regeneration pin to be connected to an external regeneration resistor. Designed for 16A (not protected). When Regeneration is triggered, this pin is connected internally to PGND. The other end of the external regeneration resistor should be connected to VB+, the Internal DC Bus power (pin 1).

Connector Manufacturer: Phoenix Contact
Mating Connector Part number: 1942484
(Wurth Electronics equivalent: 691340500002)
(Degson equivalent: 2EDGKDM-5.08-2P-14)
Connector Pitch: 5.08mm

Important Notes:

- The regeneration feature, once enabled, is always active, regardless of the motor status (enabled/disabled).
- Current will flow in the regeneration resistor depending on the values of RegenOn and RegenOff, and the power supply voltage.
- There are no current and/or power protections to protect the regeneration resistor or the internal MOSFET!
- Take care to set the suitable regeneration parameters for the supply voltage and the external regeneration resistor.

- Plug in the regeneration resistor only after all parameters are set properly and always when the controller power is off.
- Let the regeneration resistor cool down before touching it. Unplug it only when the controller power is off.
- During development, if the supply voltage is to be modified, first disconnect the regeneration resistor and remember to adjust the regeneration parameters to match the new supply voltage, before connecting again the regeneration resistor.
- We recommend adding external protections (such as PTC) to protect the regeneration resistor.

3.3.4.2 DIP Switches

The product includes 8-way DIP switches to define CAN or Ethernet address offset, connect a 120-ohm CAN terminator resistor, turn on a forced firmware-download mode, etc. These are hardware configurations that are typically done only once during the product installation.

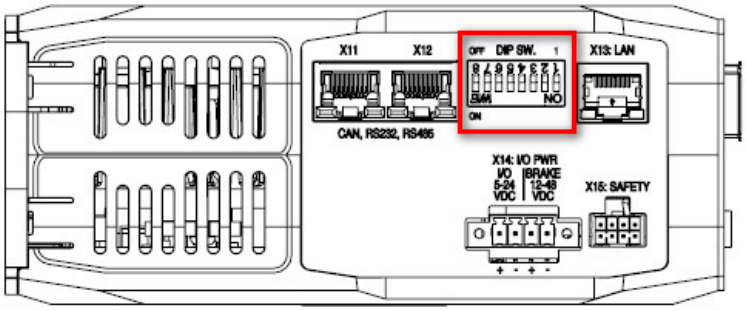


Figure 15 DIP Switches

DIP SW.:

DIP Switch #	Function	Description
1	CAN Bus Terminator	Set to ON to connect 120-ohm terminator resistor. Only the last unit in the CAN network needs to have this set to ON.
2	Force Download FW	Set to ON and **power cycle** to force the product into firmware download mode. Always keep at OFF state otherwise.
3	Force Communication to Default	Forces the controller to default communication parameters as follows (bypassing other software parameters in the controller): Ethernet IP: 172.1.1.101 Ethernet Port: 50000 CAN Address: 64 Note: CAN and RS232/USB baud rates are not affected by this DIP Switch. Requires **power cycle or reset**.
4-6	CAN/Ethernet Address Offset DIP Switch 4 – Most significant bit DIP Switch 6 – Least significant bit	DIP Switches 4-5-6 creates a three bits value. For example, if DIP Switch 4 is set to ON (value of 1), 5 and 6 are set to OFF (value of 0), we get: 100 (binary), which means a value of 4. This value (referred to as **offset** below) is used to define the product's CAN Bus Address and Ethernet IP Address as follows: Ethernet IP: the actual 4th number of the IP address is equal to: EthernetIP [4] + **offset** CAN address: the actual CAN address of the unit is equal to:

		CANAddr + **offset** * 16 Note: Requires **power cycle or reset**.
7	Reserved for Future Use	Always keep at OFF state.
8	Reserved for Future Use	Always keep at OFF state.

Notes:

- The value of the DIP Switches, as read by the controller during power on (or reset) can be queried using ADebugData[4] at PCSuite terminal.

3.3.4.3 X15: Safety

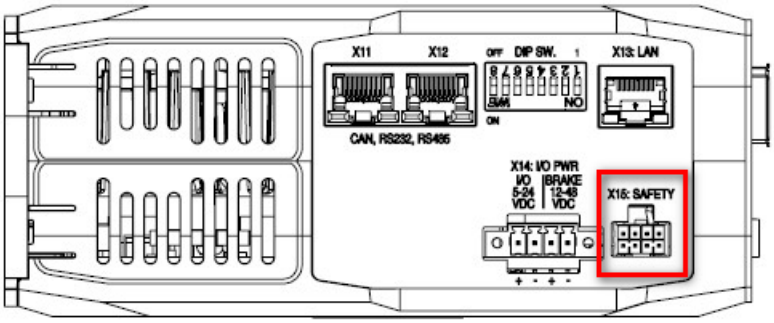


Figure 16 Safety Connector

Connector X15: SAFETY

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

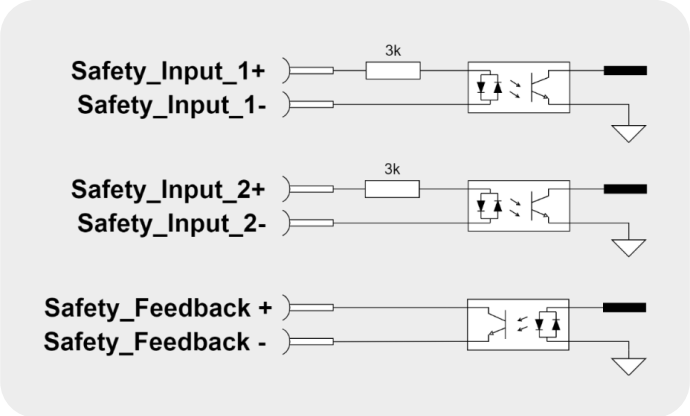
Connector Manufacturer: Samtec Inc.
Mating Connector Part number: IPD1-04-D-K
Crimp Contact Part Number: CC79L-2630-01-L (or equivalent)

Notes – Safety Inputs Implementation:

- Both Safety_Input_1 and Safety_Input_2 are completely independent. Each one of them disables the power to the motor in a different way.
- Both Safety_Input_1 and Safety_Input_2 disable the power to the motor by hardware circuitry, without any software intervention.

- The safety inputs implemented in the product are not certified to Functional Safety Standards.
- The Safety_Input_1 and Safety_Input_2 are defined with a positive pin (+) and a negative pin (-). However (refer to the electrical interfaces described below) the opto-coupler at the Safety_Input (also for all other discrete, isolated inputs of the product) is equipped with two input diodes, enabling operation at "positive" or "negative" input voltage. The input is activated by (enough) current at one of the input diodes, independently of the current direction. This enables NPN or PNP connection to the safety inputs (independently).
- The Safety_Input protection logic is designed such that both Safety_Inputs must be powered in order to enable motor operation. Leaving a Safety_Input disconnected will prevent motor operation. This logic is required in order to ensure that a disconnected safety cable will be considered by the control unit as an unsafe situation. When (enough) current is driven through a Safety_Input, the state of this input is "safe". When no (not enough) current is driven through a Safety_Input, the state of this input is "unsafe".
- The two Safety_Inputs must be at "safe" state in order to enable motor operation.
- Both Safety_Input_1 and Safety_Input_2, although acting on the drive hardware directly, are also sensed by the controller software. The controller software is generating a feedback signal to the user (Safety_Feedback) which is also an isolated signal. This feedback is generated by the software and is activated in case at least one of Safety_Input_1 or Safety_Input_2 signals is at unsafe state.
- The electrical characteristics of the Safety_Input_1 and Safety_Input_2 are identical to those of the discrete, isolated inputs of the controller.

Electrical interfaces – Safety Connector:



4. Operation Instruction

4.1 Software 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.

Connect the product to power supply, motor, encoder and other I/Os cable according to the electrical interface section. Ensure that the safety port is connected before any operation.

Open PCSuite software. Select SYS in CONFIG below and setup the parameters as follows:

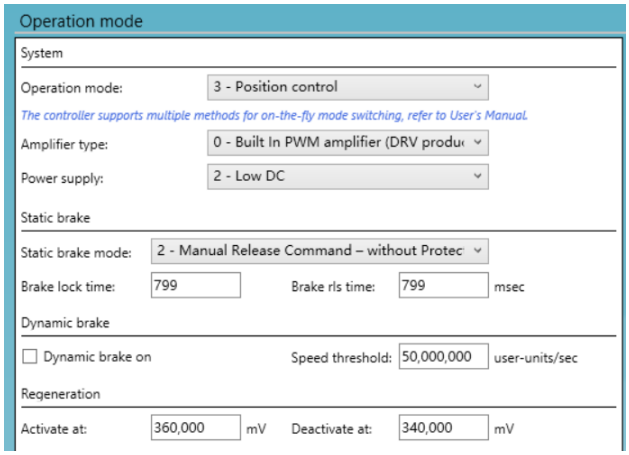


Figure 17 Operation Mode configuration

Click 'Next' and set the motor type and number of pole pairs according to the test motor：

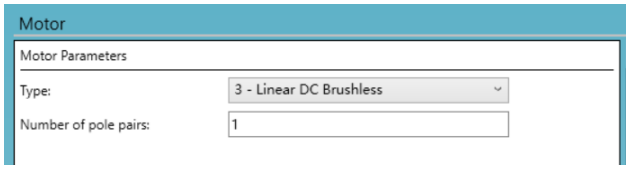


Figure 18 Select Motor Type

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),

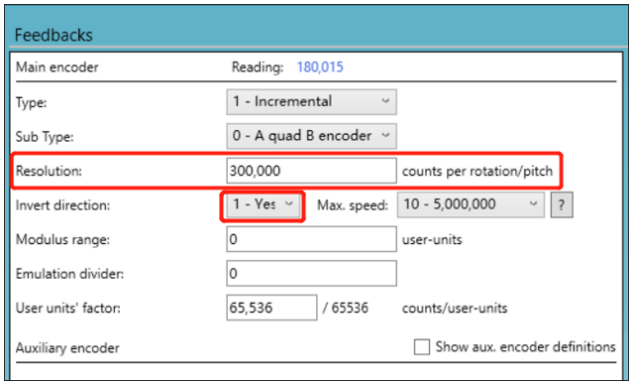


Figure 19 Feedback Parameters

Note: Value of 'Invert direction' affects commutation of the motor, it is required that the encoder is 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.

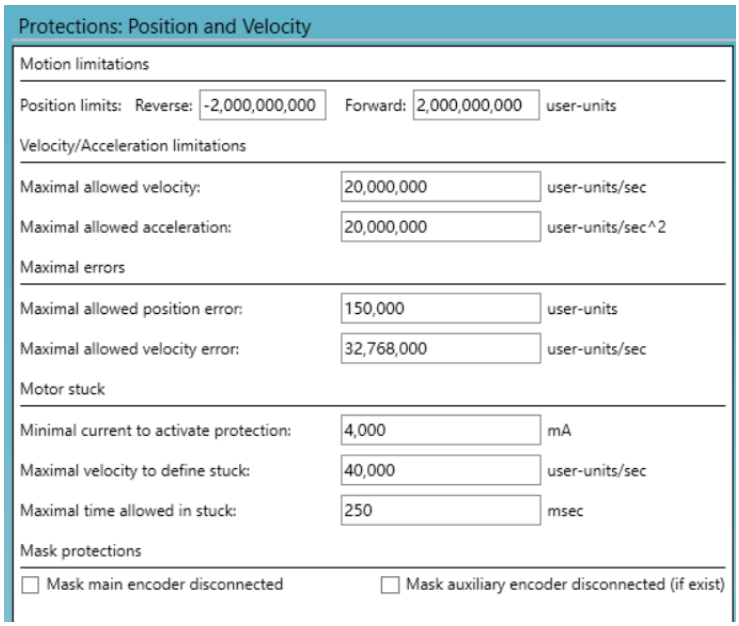


Figure 20 Position and Velocity Protection

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.

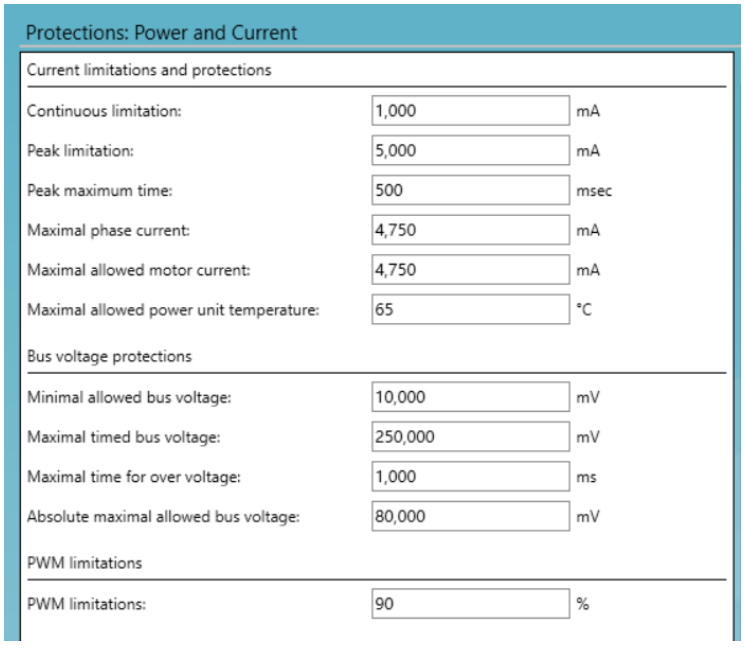
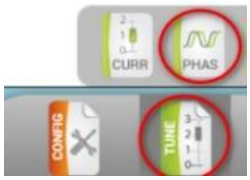


Figure 21 Current and Voltage Protection

4.2 Tuning

4.2.1 Auto Phasing



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 doesn't allow such search distance, select "Minimal Motion" method.

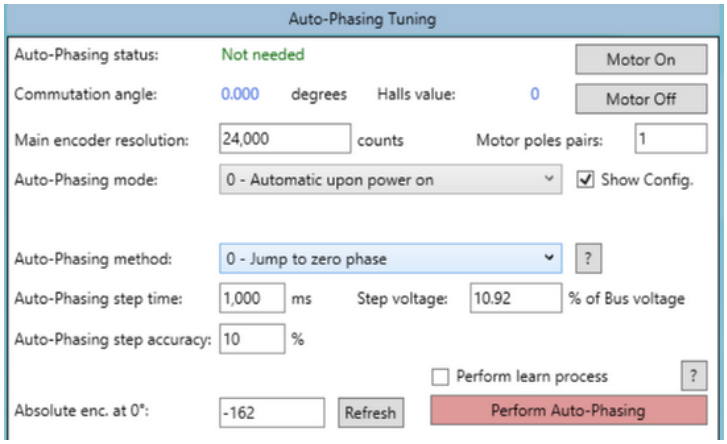


Figure 22 Auto-Phasing for Brushless motor

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

1. Connect Hall sensors to "HALLS" port and configure the first of the three inputs in the digital I/O page as "Hall A".
2. Use the "Jump to zero phase" method to establish the motor and hall phases, check the "Perform learn process" checkbox and click on "Perform Auto-Phasing".
3. 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.

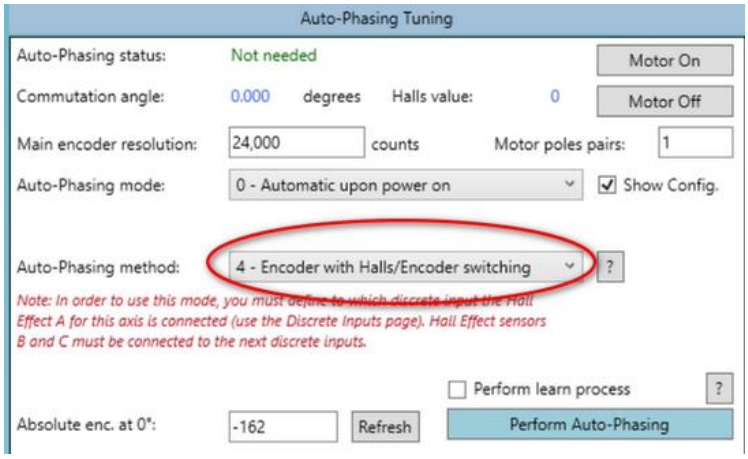
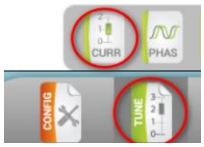


Figure 23 Using Hall Sensors to avoid "Shake and Wake"

4.2.2 Current Loop Tuning



Select TUNE -> CURR. Enter motor's phase resistance and phase inductance according to 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 and click "Apply Current Command" button to test the current loop performance.

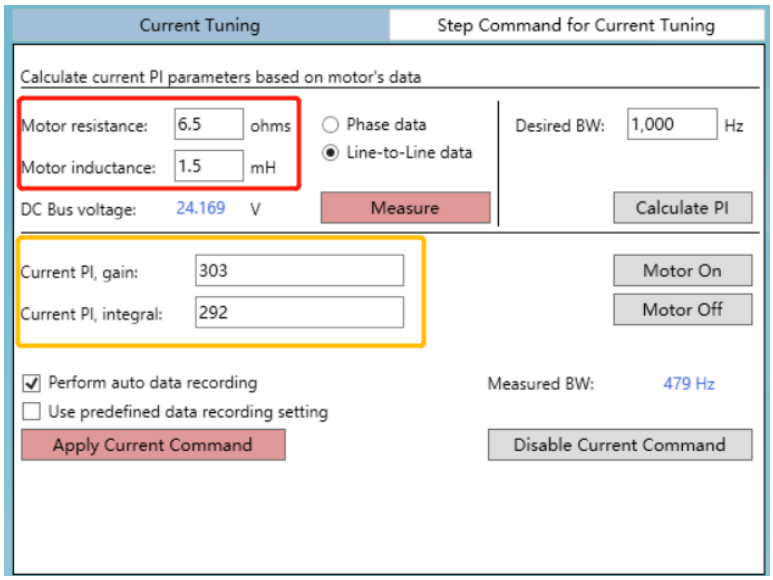


Figure 24 Current Loop Tuning

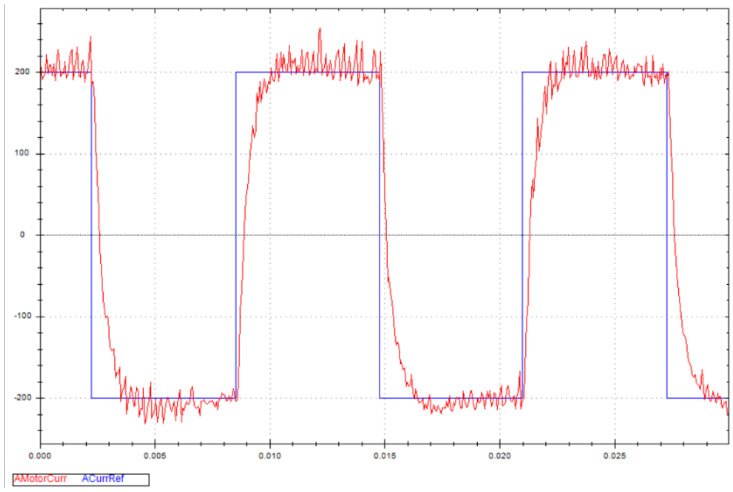
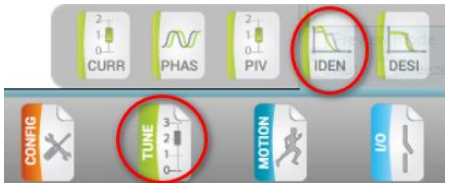


Figure 25 Typical Current Loop Performance

4.2.3 Auto Velocity and Position Loop Tuning

1. System Identification. Select TUNE -> IDEN. Click on “Begin Identification” button to perform system identification.



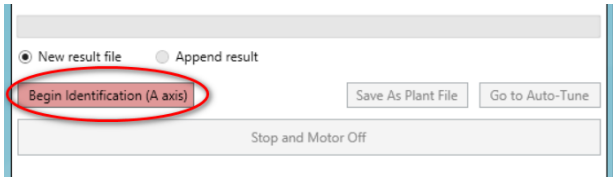


Figure 27 Begin System Identification

When the identification is completed successfully, the plant’s transfer function, like the picture on the right, will be shown.

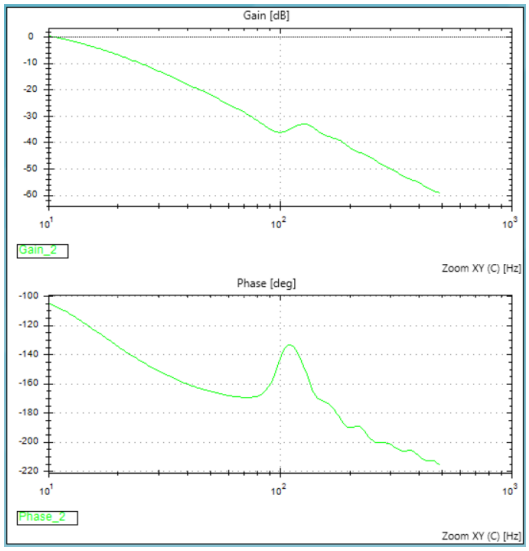


Figure 26 Typical Plant Transfer Function

2. Next, click on “Go to Auto-Tune” button. Alternatively, select TUNE-> DESI to open the Auto-Tuning (controller design) page.

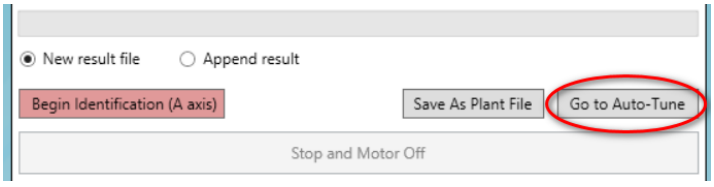


Figure 28 Go to Auto-Tuning page

3. Click on “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.

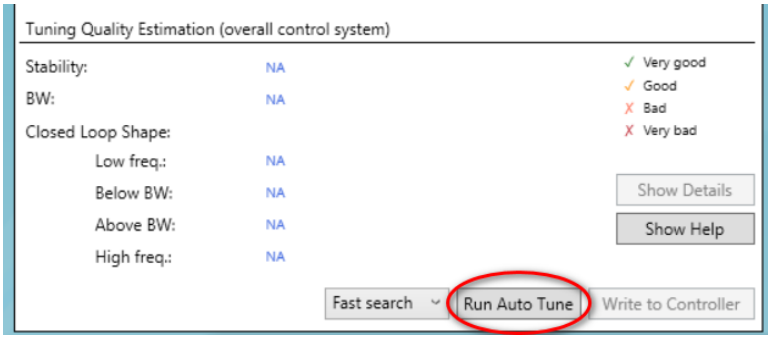


Figure 29 Start Auto-Tuning calculation

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

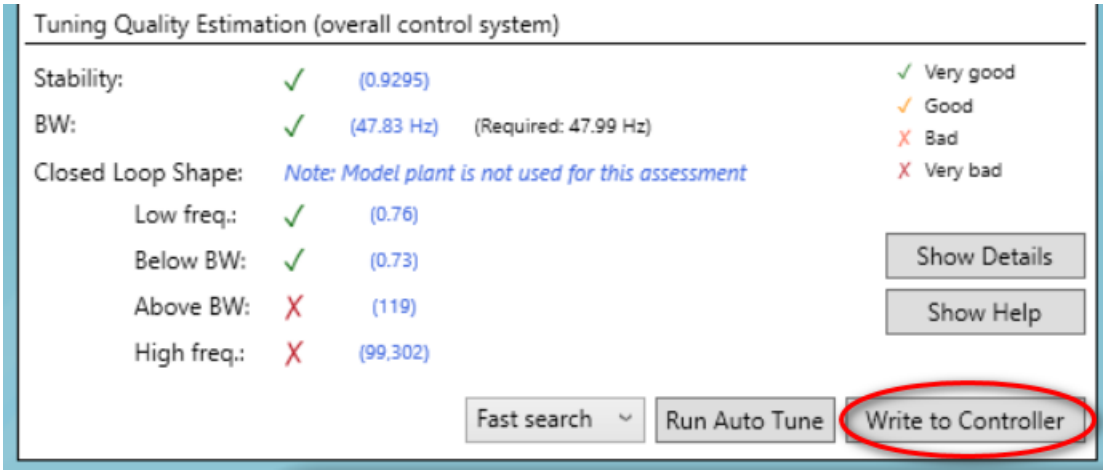


Figure 30 Download the parameters to the controller

5. Check the motion performance in the Motions Tab, setting 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.

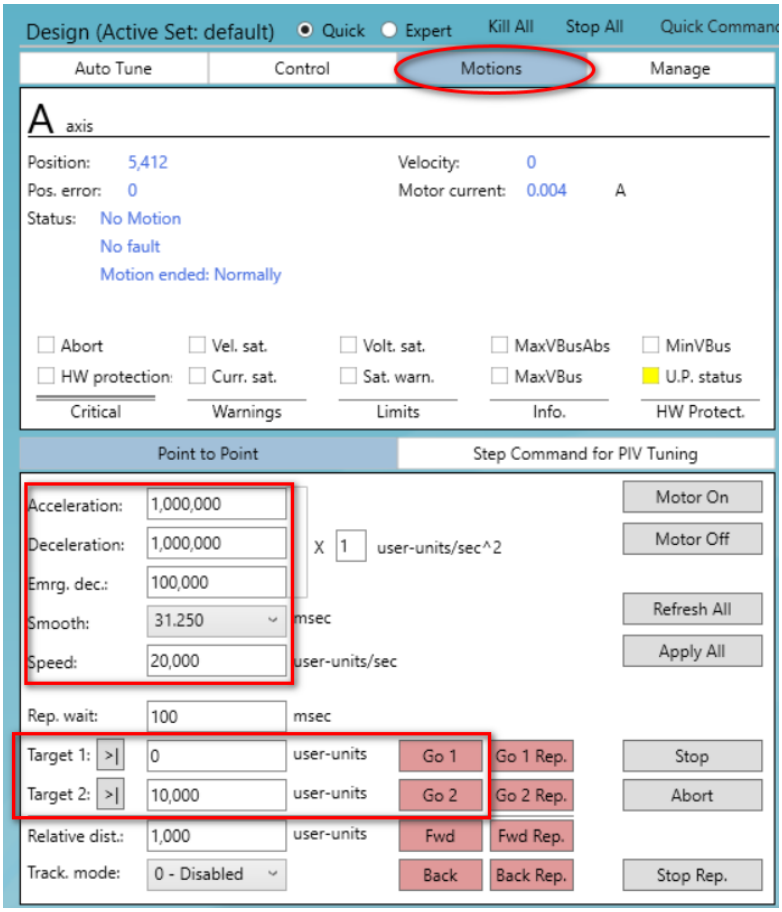


Figure 31 Testing Motion

4.2.4 Manual Velocity and Position Loop Tuning

Select TUNE -> PIV. in the tune option, adjust the proportional (“PI, gain”) and integral (“PI, integral”) gains of velocity loop, click “Apply Vel Command” to check the performance.

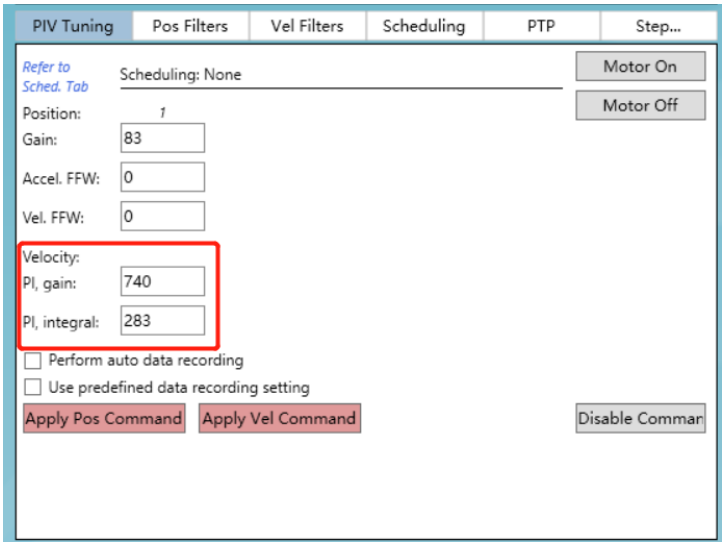


Figure 32 Manual Velocity Loop Tuning

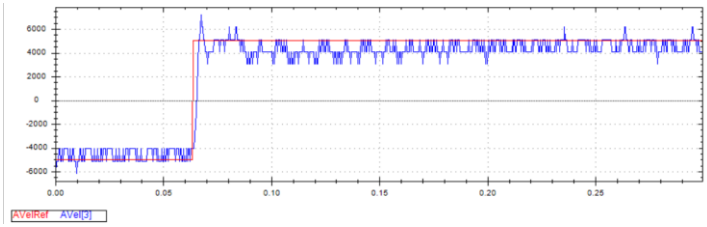


Figure 33 Typical Velocity Loop Performance

Similarly, adjust proportional gain of position loop. In addition, adjust acceleration and velocity feedforward to improve performance. Click ‘Apply Pos Command’ to check performance.

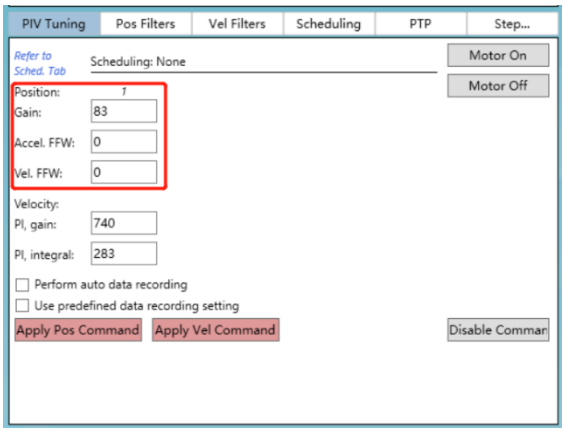


Figure 34 Position Loop Tuning

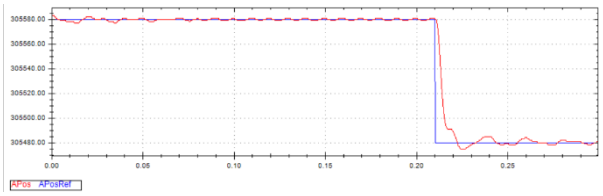


Figure 35 Typical Position Loop performance

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 in Figure 32 Testing Motion.

5. Maintenance and Servicing Instruction

Possible fault conditions:

Condition	Potential Cause	Possible Resolution
Power is On but no LED light	Power connector is loose	Check power connector, measure power supply voltage using a volt-meter.
	Firmware is corrupted	Turn on DIP SW. #2, power cycle and download firmware using PCSuite.
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 PCSuite's CONFIG -> FDBK page, toggle the "Invert direction" 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. Set EncFilt from 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 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 PCSuite's TUNE -> PIV, Velocity Filters tab.
	Mechanical resonance.	Add a software low pass filter from PCSuite's TUNE -> PIV, Velocity Filters tab.

		Do advanced auto tuning to allow 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.
	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 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 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