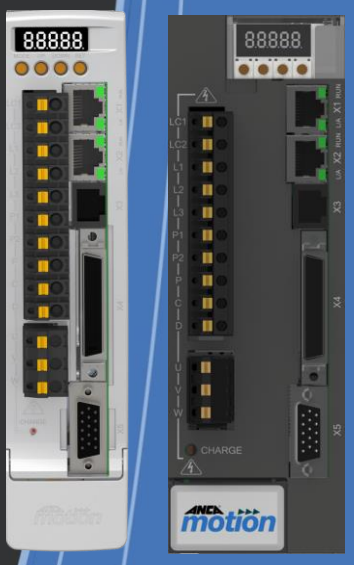
AMD2000 Series D21xx Servo Drive - User Guide



D-000088 Rev 06

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AMD2000 Series D21xx Servo Drive - User Guide

Some Important Links

Related User Guides and Brochures	*Related Documentation*
Sales and Support Contact Information	*Product, Sales and Service Enquiries*
For the latest copy of the user guide visit us online	*User Guides*
For the latest version of the ANCA MotionBench Software visit	*Software*

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Chapter Summaries

1	Safety	General Product safety information
2	Introduction	Target Audience, model applicability, help in reading the user guide and related user guides/brochures
3	Product Overview	Features, operating principles, labels, connector overview
4	Mechanical Installation	Requirements for site, tools, mounting, and cooling
5	Planning the Electrical Installation	Motor and drive compatibility, electrical isolation, protection, cable selection and routing
6	Power Wiring	Insulation, earthing, power conditioning, brake connection and regenerative brake
7	Control Wiring	Electrical Interfacing with the I/O connectors, EtherCAT and motor feedback
8	Installation Checklist	Pre-power-up checks
9	Start-up	Refers to suite of configuration guides
10	Technical Data	Functions, specifications, dimensions, de-rating, brake resistor calculation, standards compliance
11	Accessories	Selection of accessories including motors, cables, I/O interface modules, filters, reactors, chokes magnetic cores
12	Additional Information	How to contact ANCA Motion with your enquiries

Contents

1 Safety

Warning: To prevent possible accidents or injury, ensure you read and understand this user guide before commencing installation or commissioning work on the AMD2000 drives.

DANGER HIGH VOLTAGE - The working DC bus is live at all times when power is on. The Main Isolator feeding the drive must be switched to the **off** position at least 15 minutes before any work is commenced on the unit. The operator must check the bus voltage with a tested working voltage measuring instrument prior to disconnecting any connectors or opening the DC Bus terminal cover. The red LED indicator on the front of the drive which indicates that there is charge remaining in the drive is only to be used as an aid to visual troubleshooting. It should not be relied on as a means of safety.

Rotating permanent magnet motors can produce large voltages. Please ensure that the motors have stopped rotating before commencing work.

This user guide and the warnings attached to the AMD2000 only highlight hazards that can be predicted by ANCA Motion. Be aware they do not cover all possible hazards.

ANCA Motion shall not be responsible for any accidents caused by the misuse or abuse of the device by the operator.

Safe operation of these devices is your own responsibility. By taking note of the safety precautions, tips and warnings in this user guide you can help to ensure your own safety and the safety of those around you.

The AMD2000 is equipped with safety features to protect the operator and equipment. Never operate the equipment if you are in doubt about how these safety features work.

1.1 General Safety

The following points must be understood and adhered to at all times:

- Equipment operators must read the User Guide carefully and make sure of the correct procedure before operating the AMD2000.
- Memorize the locations of the power and drive isolator switches so that you can activate them immediately at any time if required.
- If two or more persons are working together, establish signals so that they can communicate to confirm safety before proceeding to another step.
- Always make sure there are no obstacles or people near the devices during installation and or operation. Be aware of your environment and what is around you.
- Take precautions to ensure that your clothing, hair or personal effects (such as jewellery) cannot become entangled in the equipment.
- Do not remove the covers to access the inside of the AMD2000 unless authorized
- Do not turn on any of the equipment without all safety features in place and known to be functioning correctly. Never remove any covers or guards unless instructed by the procedures described in this user guide.
- Never touch any exposed wiring, connections or fittings while the equipment is in operation.
- Visually check all switches on the operator panel before operating them.
- Do not apply any mechanical force to the AMD2000, which may cause malfunction or failure.
- Before removing equipment covers, be sure to turn OFF the power supply at the isolator. (Refer to *4.4.1 Power Isolation*.) Never remove the equipment covers during operation.
- Keep the vicinity of the AMD2000 clean and tidy.
- Never attempt cleaning or inspection during machine operation.

- Only suitably qualified personnel should install, operate, repair and/or replace this equipment.
- Be aware of the closest First Aid station.
- Ensure all external wiring is clearly labelled. This will assist you and your colleagues in identifying possible electrical safety hazards.
- Clean or inspect the equipment only after isolating all power sources.
- Use cables with the minimum cross sectional area as recommended or greater.
- Install cables according to local legislation and regulations as applicable.
- Insulation resistance testers (sometimes known as a 'megger' or hi-pot tester) are not to be used on the drive, as a false resistance reading and/or damage to the drive may result

1.2 Safe Start-Up and Operation

Please refer to sections *8 Installation Checklist* and section *9 Start-up* for additional checks that should be made to start up the AMD2000 series drives safely.

2 Introduction

2.1 What this Chapter Contains

This chapter introduces reader to the user guide, the target audience and some useful information with regards to comprehending the content.

2.2 Purpose

This user guide provides the required information for planning to install, installation and servicing of the AMD2000 Series Servo Drive. It has been written specifically to meet the needs of qualified engineers, tradespersons, technicians and operators. This user guide does not cover configuration of the drive. Depending on the model of drive purchased, please refer to the applicable Servo over EtherCAT® Configuration Guide or CANopen over EtherCAT® Configuration Guide, for information on parameter configuration and tuning for your application.

Every effort has been made to simplify the procedures and processes applicable to the AMD2000 in this User Guide. However, given the sometimes complex nature of the information, some prior knowledge of associated units, their configuration and or programming has to be assumed.

2.3 About the AMD2000 Series D21xx Servo Drives

The AMD2000 Series D21xx Servo Drives are capable of motion control for applications that may vary from precise control of movement and angular position of permanent magnet synchronous motors through to less rigorous applications such as simple speed control of induction motors. In many of these applications the rotational control of the motor is converted to motion using mechanical means such as ball screws and belts.

Both the D2103 and D2109 drives covered by this user guide incorporate a Safe Torque Off (STO) function, allowing an external safety system to disable the PWM switching in the drive in a reliable and safe manner, and consequently shutting down the delivery of torque to the driven machinery. This function is often used to replace external safety contactors, thereby reducing the need to re-start power up sequences in machinery, and reducing the total safety system costs for the end user.

Motion control is performed by the drive controller which accepts position feedback from motor encoders and/or separate linear scales. The drive utilizes state-of-the-art current-regulated, pulse-width-modulated voltage-source inverter technology that manages motor performance. In general, the Drive control receives motion control commands via a higher level controller, which is based on an Ethernet-based field-bus interface. In certain applications the drive is capable of executing pre-defined moves that are stored in local memory, without the use of a motion controller. The AMD2000 drive also supports position, velocity and torque control modes.

Please refer to *3.2 Features* for more details of features available

2.4 Drive Model Applicability

This user guide is applicable to the following variants of the ANCA Motion AMD2000 Series Servo Drives:

Product	Product variant	Product Number
AMD2000 Series Servo Drive	3A RMS with STO	D2103
	9A RMS with STO	D2109

2.5 Related Documents

AMD2000 Series Servo Drive – CoE Configuration Guide

AMD2000 Series Servo Drive – SoE Configuration Guide

ANCA Motion MotionBench – User Guide

Digital Servo Drive CoE/SoE Parameter Reference – Included with firmware bundle

Digital Servo Drive Error Code Reference – Included with firmware bundle

2.6 Terms and Abbreviations

DSD	Digital Servo Drive
EMC	Electromagnetic Compatibility
IEC	International Electrotechnical Commission
I/O	Bidirectional Input / Output
O	Output
AIN	Analogue Input
AOUT	Analogue Output
DI	Digital Input
DO	Digital Output
W.R.T.	With Respect To
GND	Ground
RMS	root mean square
V / mV	Volt / millivolt
A / mA	Ampere / milliamp
Φ	Phase
Ø	Diameter
Ω	Ohms
AC / DC	Alternating Current / Direct Current
Hz	Hertz
ms	Millisecond
SoE	Servo Drive Profile according to IEC 61800-7-204 over EtherCAT®
CoE	CAN Application Protocol over EtherCAT®
CNC	Computer Numerical Control
DCM	Drive-Controlled Moves
PMSM	Permanent Magnet Servo Motor
PMAC	Permanent Magnet Alternating Current
STO	Safe Torque Off
PE	Protective Earth
PN panels	Part Number Panels

2.7 Trademarks

EtherCAT® is a registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany.

3 Product Overview

3.1 What this Chapter Contains

This chapter introduces reader to the D21xx servo drive by providing the following information

- Features,
- Operating Principle
- Explanation of Labelling and Markings
- Connector overview

3.2 Features

The D21xx is a versatile brushless AC servo drive incorporating a digital signal processor (DSP) for control of rotary and linear motors. In general, the drive receives motion commands via a higher level controller, such as a CNC, either in the form of structured position commands, or as a series of instructions controlling one or more user pre-defined moves stored locally on the drive. The communication is based on the state-of-the-art EtherCAT® interface. In certain applications the drive is also capable of running in standalone mode executing pre-defined repetitive moves

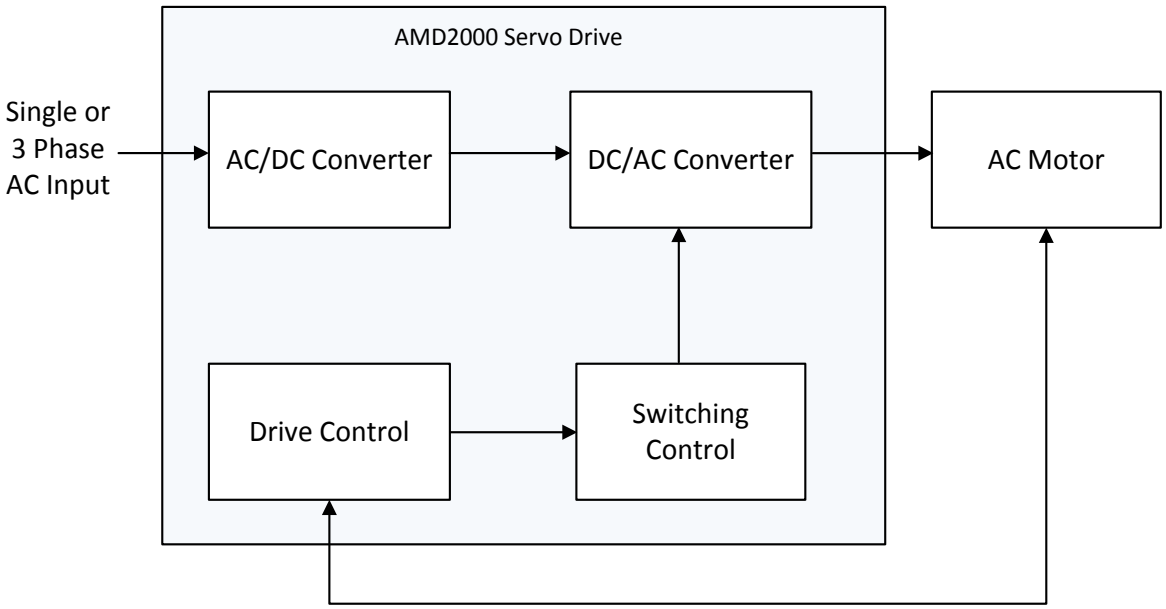
Standard features include:

- Single axis drive for AC synchronous servo motors and induction motors.
- Models with continuous current ratings of 3A or 9A.
- Direct connection to 100V – 240VAC single phase or 3-phase.
- Support for incremental analogue and digital encoders.
- Position, velocity and torque/current control.
- Display and push buttons for standalone operation.
- 8 optically isolated general purpose digital inputs.
- 6 optically isolated general purpose digital outputs.
- 2 differential digital inputs (optionally can be used as additional general purpose digital inputs, for a total of 10)
- 2 analogue inputs (±10V) and 2 analogue outputs (±10V).
- Motor brake control.
- Probe input for position latching.
- Safe Torque Off (STO)
- EtherCAT® connectivity.
- Easy setup using ANCA MotionBench Tool.
- Small foot print. On-board 24VDC power supply and auxiliary I/O reduce overall system size and cost.
- Rugged and reliable design

Please refer to section *10 Technical Data* for detailed product specifications

3.3 Operating Principle

The simplified circuit diagram of the drive is shown below. The AC supply voltage is converted to DC, which is then converted into the required variable frequency AC voltage signal to drive the motor.

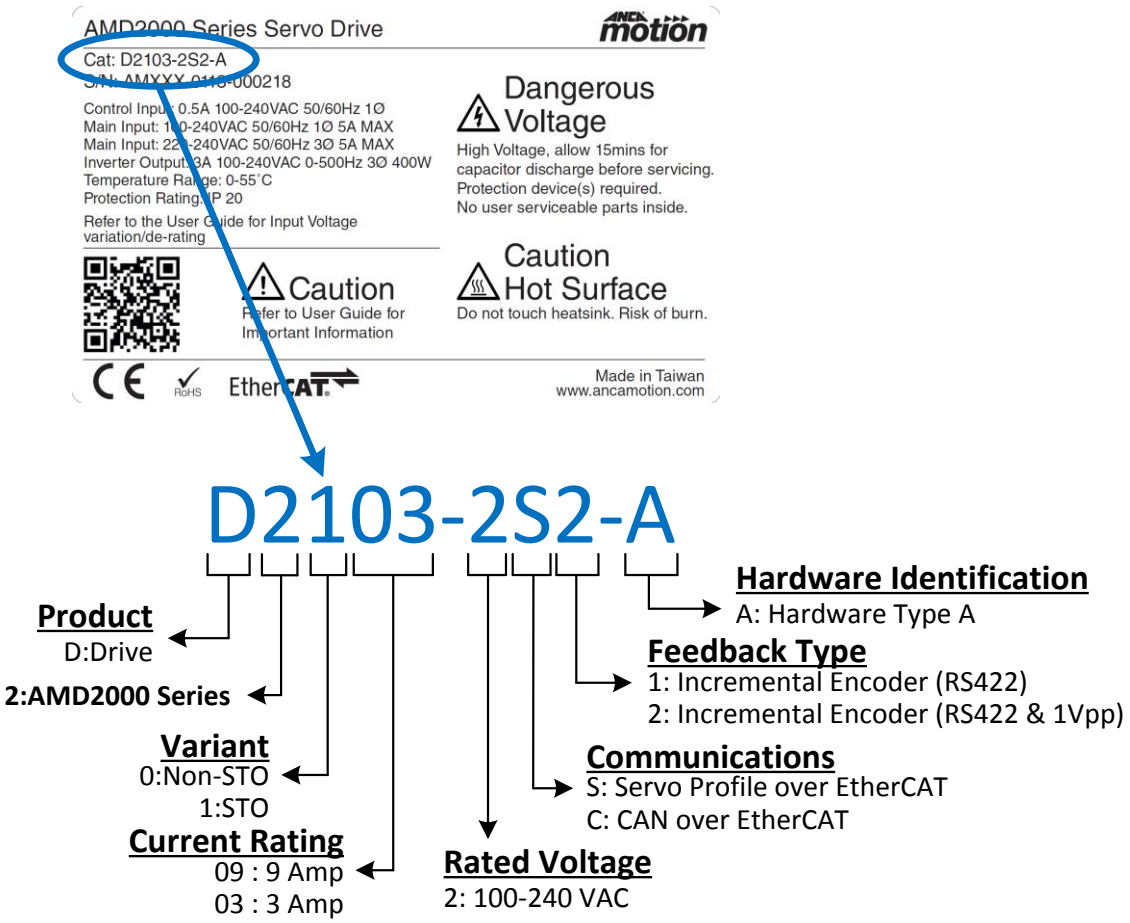


3.4 AMD2000 Variant Identification

D2103		D2109	
			

3.4.1 AMD2000 Series Drive Catalogue Number Interpretation

AMD2000 drives are marked with an identification label. The Catalogue number is explained as follows:



For any warranty work to be undertaken these labels must be readable and undamaged. Care should be taken to record these numbers in a separate register in the event of damage or loss.

Note: Do not under any circumstances tamper with these labels. Your warranty may be void if the labels are damaged.

3.5 System Overview

A digital drive system comprises one or more digital servo drives as shown in the following Figure:

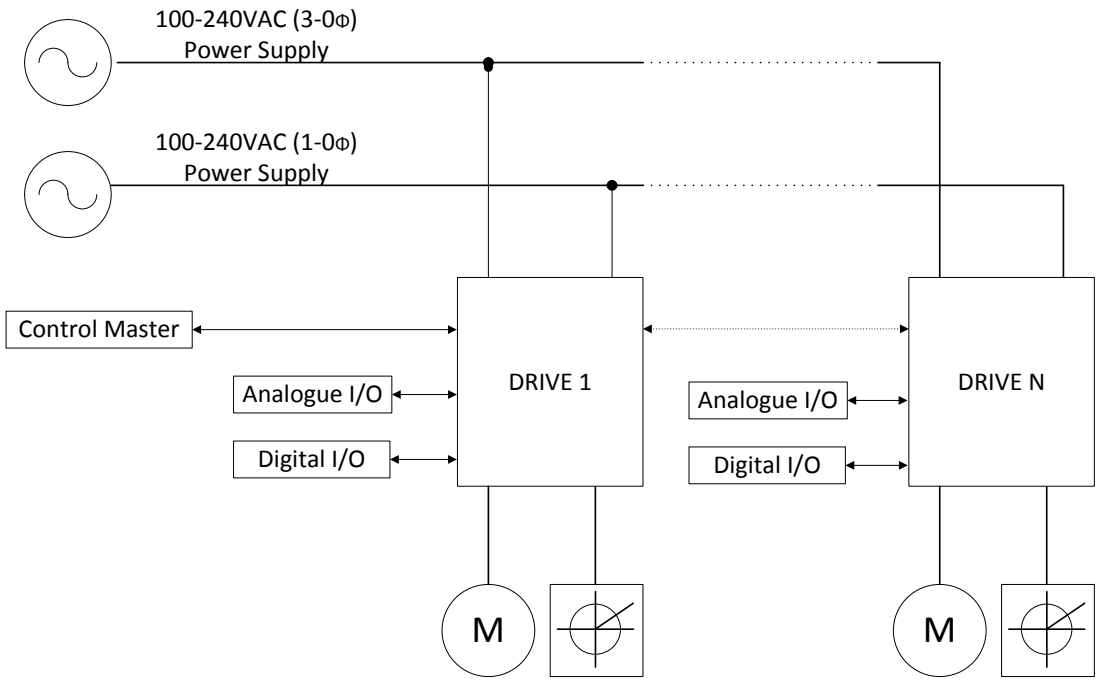


Figure 3-1 System Overview

Above example is of a drive system is supplied from a single or three phase mains connection with a nominal voltage of 230VAC. Motion control commands are received from a control system, such as a CNC, either in the form of structured position commands, or as a series of instructions controlling one or more user pre-defined moves stored locally on the drive.

The following figure provides a block diagram of the drive system. There are two versions of drive system available corresponding to maximum continuous motor current ratings of 3A and 9A. The EtherCAT communications channel is routed between the components within the drive system and the external control system via CAT5E or CAT6 Ethernet cabling. This communications channel provides interconnectivity for the purpose of transmitting and receiving data, such as position commands.

Alternatively, each drive can be controlled through a combination of analogue and digital I/O. A number of analogue inputs and digital inputs/outputs are provided in each drive for user defined signals which may be used for application specific functions.

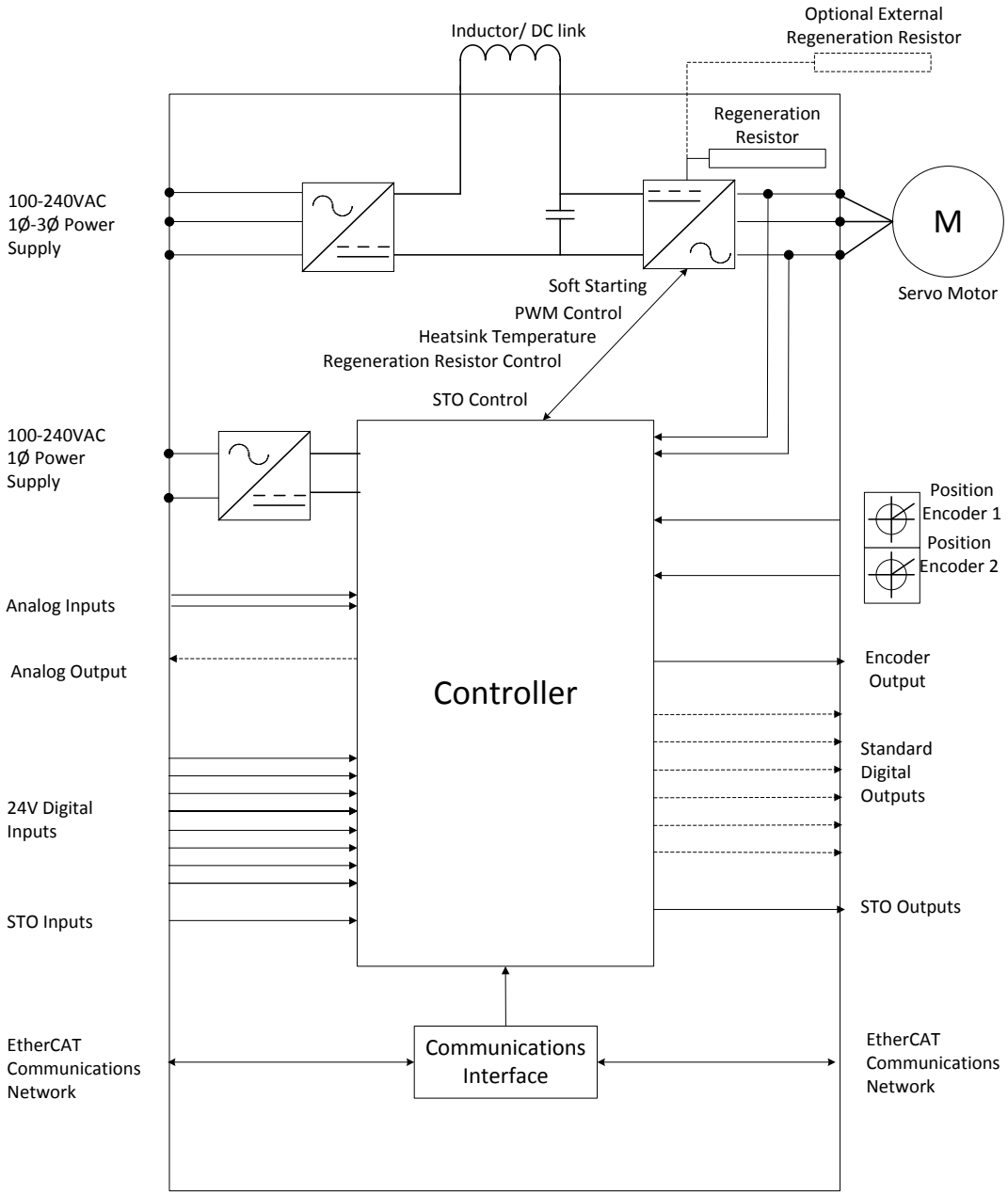


Figure 3-2 Block Diagram of the Drive System

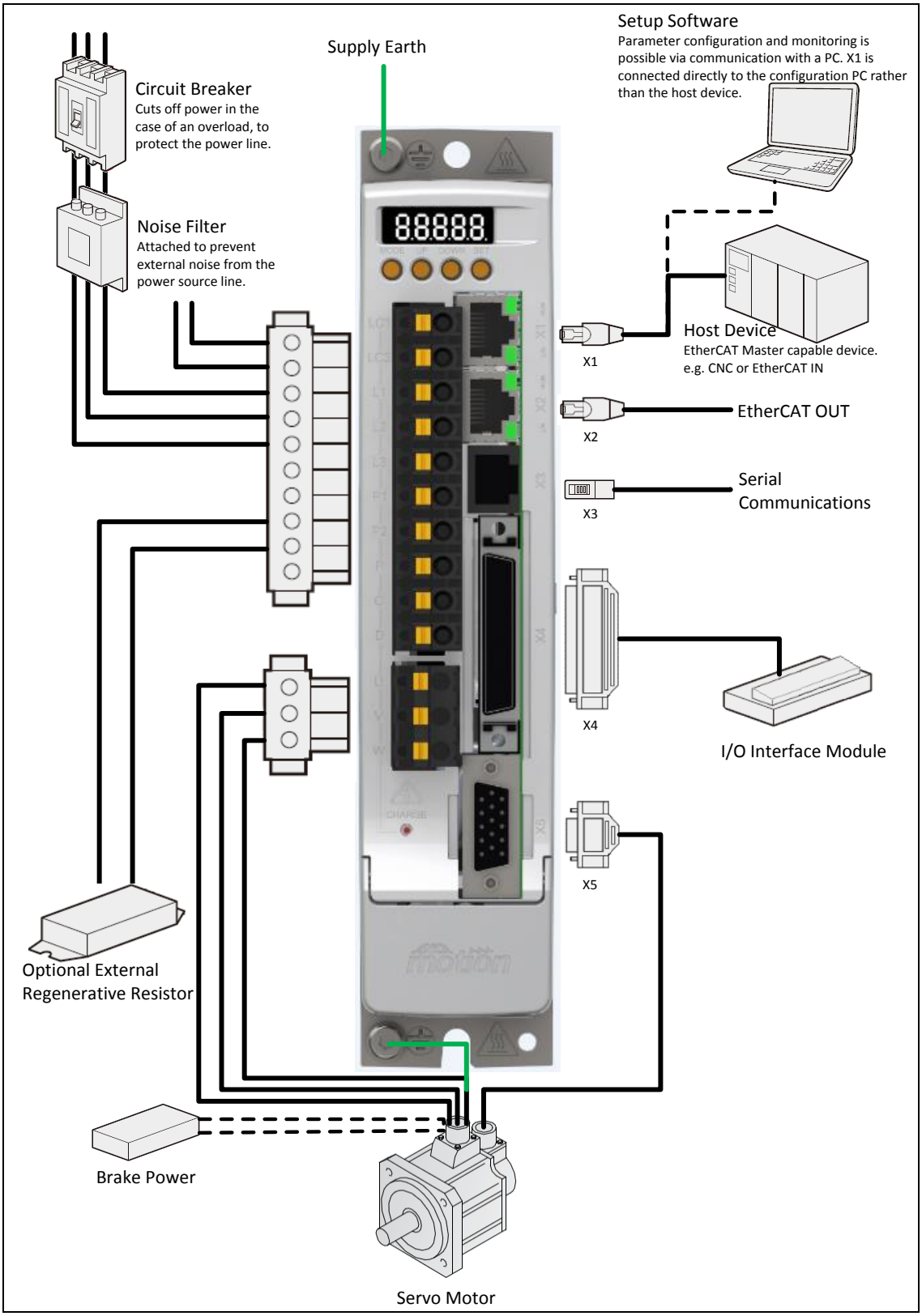


Figure 3-3 Connection Overview

3.6 Connector Overview

3.6.1 D2103

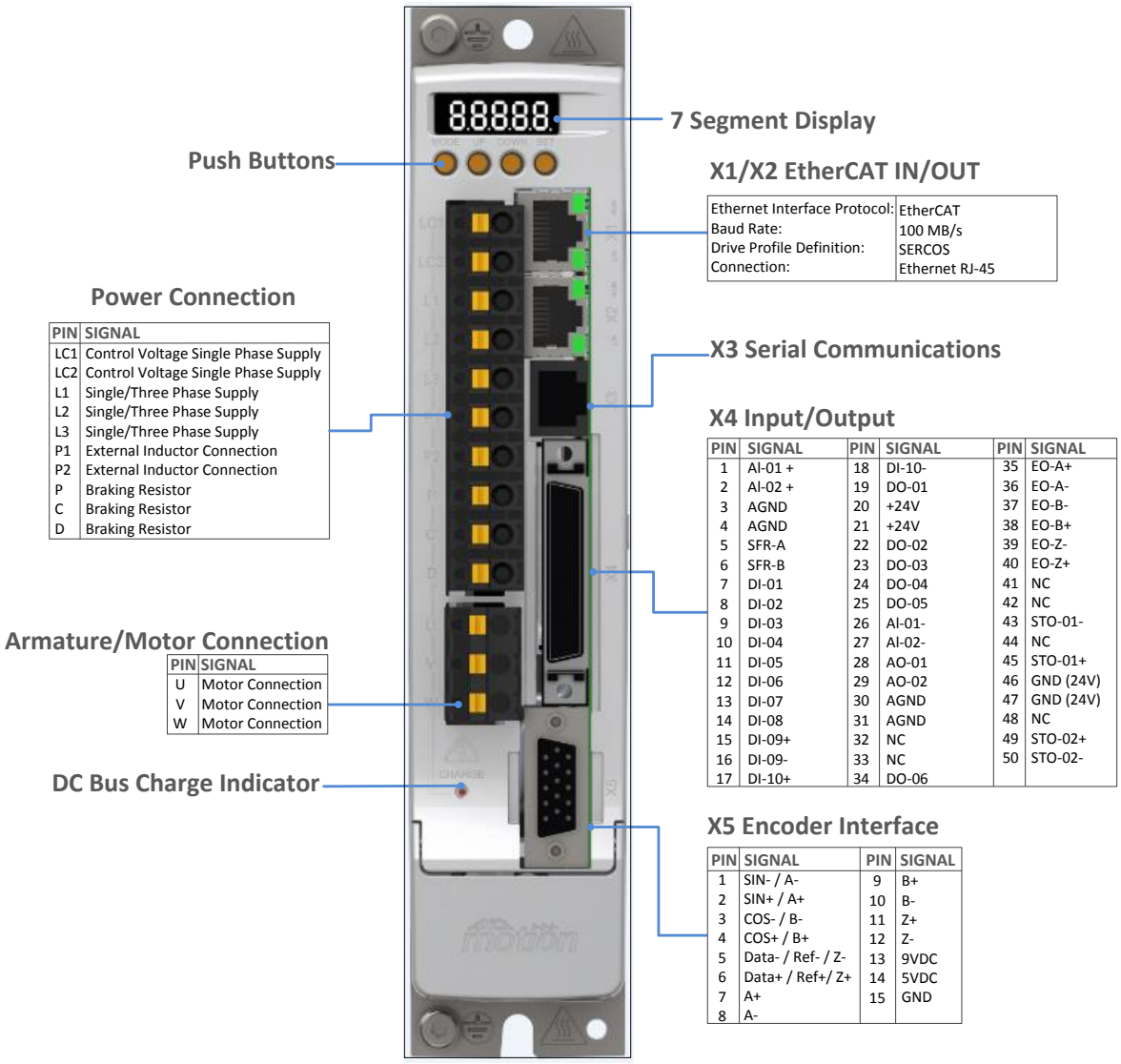


Figure 3-4 Connector Summary D2103 Servo Drive

3.6.2 D2109

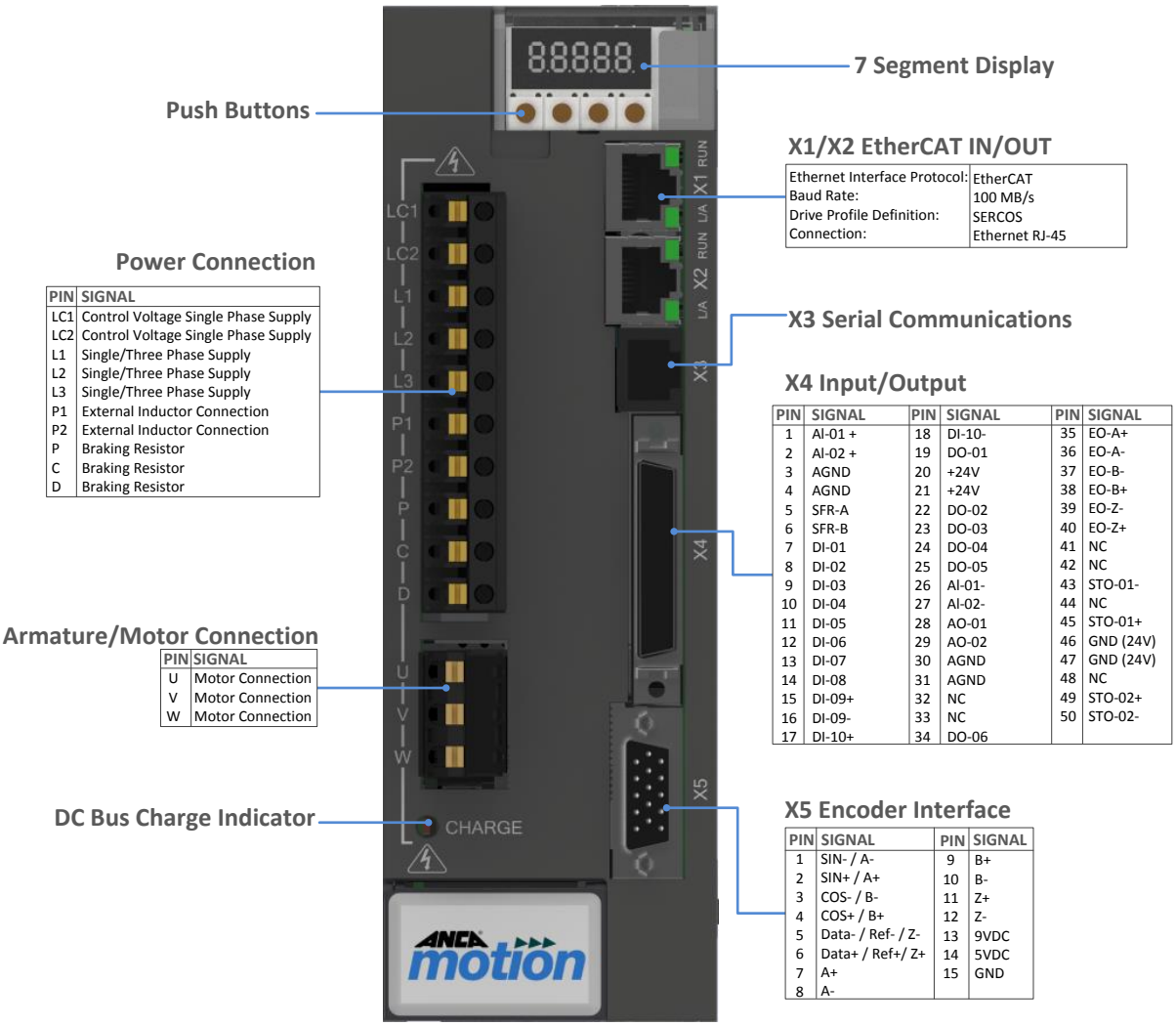
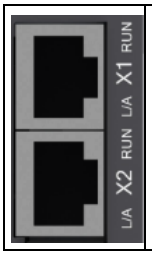


Figure 3-5 Connector Summary D2109 Servo Drive

3.6.3 X1/X2 EtherCAT Connectors

	X1	EtherCAT IN
	X2	EtherCAT OUT

3.6.4 X3 Serial Communications

	X3	The X3 serial port is an RS232 and RS485 communications interface which implements the Modbus protocol. Not supported on D21xx.

3.6.5 X4 Input / Output

	X4	Connection interface to analogue I/O, digital I/O and STO.

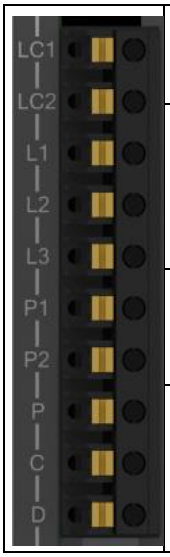
3.6.6 X5 Encoder Interface

	X5	Port for an encoder interface. Its purpose is to provide encoder position feedback.

3.6.7 Motor Armature Cable Connectors

	U V W	Motor armature cable connection

3.6.8 Power, Inductor and Brake Resistor Connectors

	LC1 LC2	Single phase supply for control power
	L1 L2 L3	Single phase or three phase supply for DC bus
	P1 P2	External inductor connection. P1 and P2 are in series with DC BUS+ and might be connected to an external inductor for extra energy storage and reducing voltage ripple.
	P C D	Brake resistor connection

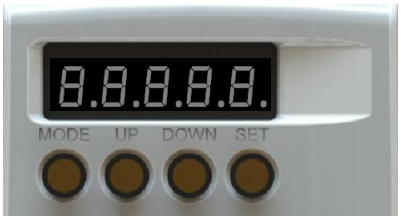
When an inductor on the DC bus is not used, a link rated at full drive current must be placed across P1 and P2 to avoid E0303 DC bus Voltage low alarm.

If an external brake resistor is not installed a link must be placed across P and D to be able to take advantage of the internal brake resistor to dissipate regenerative energy.

For Additional Information refer to section *6.13 Brake/Regeneration Resistor .*

3.6.9 LED Display and Control Panel

The AMD2000 series drives are fitted with a LED display and control panel as shown in the following figure:



The characteristics of the display and control panel are detailed in the following table:

Drive Display	
Indicator	5 x 7-segment LED
Operator interfacing	4 DIP buttons

4 Mechanical Installation

4.1 What this Chapter Contains

This chapter contains information that is relevant to the mechanical installation of the drives in an electrical cabinet such as

- Pre installation checks
- Installation requirements
- Tools required
- Mounting and cooling
- Mechanical installation

4.2 Pre installation checks

- Prior to installing the drive into the electrical cabinet, check the information on the designation label (located on the side of the drive). Please refer to section *3.4 AMD2000 Variant Identification*.
- Check that drive was not damaged during transport. If there are signs of damage the drive may not be safe to use. Please notify shipper immediately of the damage and DO NOT install the drive into the electrical cabinet.

Warning: To avoid injury when handling the drives, wear appropriate PPE (Personal Protective Equipment). Remove any trip hazards that could result in dropping the drive and causing injury.

Caution: Damage due to electrostatic discharge (ESD). Electrostatic discharge can damage components. When handling the servo drives during installation or removal, ensure against discharge before touching the product, e.g. by touching an earthed, conductive surface or by wearing an earthed armband.

4.3 Requirements

4.3.1 Installation Site

The following is a set of requirements on the installation site. Failure to follow these instructions may result in drive failure or degraded operation.

- The AMD2000 Series Servo Drive must be permanently fixed in an enclosed electrical cabinet and fitted by trained, qualified personnel.
- Refer to the *4.3.3 Mounting and Cooling* for the correct installation process.
- The safety precautions outlined in *1 Safety* must be understood and adhered to.
- The operating environment must not contain corrosive substances, metal particles, dust, flammable substances or gases.
- Ensure that there are no devices mounted adjacent to the drives that produce magnetic fields. If you need to mount these devices next to the drives, ensure that there is a safe distance between them or shield the magnetic fields.
- The maximum recommended operating altitude is 1000m above sea level
- The AMD2000 must be installed in a cabinet or enclosure of rating IP54 or higher. Higher IP ratings may be required depending on application.

Refer to *10.5 Environmental Specifications* for further requirements.

4.3.2 Tools Required

In order to mount the AMD2000 drive, the following tools are required as a minimum.

- 4mm Hex key with ball end for the M5x0.8P.
- 3mm Hex Key with ball end for the M4x0.7P.
- All mounting screws to be Grade 8.8 minimum (high tensile grade screws). A set is provided with each drive. Refer to section *4.4.2 Mounting a Drive* for appropriate torque information.
- A small flat blade screw driver for X5 D-Sub 15pin HD connector, and X4 50 way Digital I/O connector.
- If standard ANCA Motion cables are not used, connectors are to be installed using only the crimp tool specified by the connector manufacturer.

4.3.3 Mounting and Cooling

- The AMD2000 must be installed vertically (see below for installation process).
- Adequate ventilation for the drive must be provided, and the drive must not be installed in the vicinity of other heat generating equipment or devices.
- The D2103 is designed to operate without any additional cooling methods. Cooling plates are not recommended, as these can produce condensation.
- The D2109 contains a cooling fan to allow the heat sink to be cooled.
- Both the D2103 and D2109 drives are intended to be mounted in electrical cabinets and it is the responsibility of the installer to ensure the drives are adequately earthed through the provided protected earth points denoted with the ⏚ symbol. Use appropriate M4 ring terminals for this connection.
- If armature termination brackets are required to be fitted for EMC compliance, see *6.7.2 Motor Power Cable Installation* for instructions.
- The D2103 drive operates without an additional cooling method, whereas the D2109 drive requires forced air flow from the internal fan to allow full operation within the acceptable temperature range.
- For the D2109, in the unlikely event of fan failure, the power module temperature may increase to the point that the drive will signal an error and cease to provide energy to the motor. If an over-temperature error occurs, ensure that fan is still serviceable. Additionally, the drive employs fan failure detection that will trigger an error should rotation not occur when commanded.
- If the required cooling and air flow requirements are not met, performance of the AMD2000 will deteriorate and the product lifetime will be reduced.
- The AMD2000 series drives should be mounted on a galvanised steel or bare aluminium panel with a minimum thickness of 3mm.

Warning: During operation, the D21xx regeneration resistor and heat sink mounting surfaces can reach above +90°C depending on load. Care must be taken to avoid burns or injury.

Ensure that the gear tray mounting surface is free from all combustible materials and vapours. Installers should consider carefully the combustibility of all mounting surfaces.

4.3.3.1 Mounting of drives for effective cooling inside the electrical cabinet:

- The D21xx drives should be mounted with at least 50mm clearance above and below to allow for effective cooling
- The D2103 must have at least 15mm horizontal space between itself and the cabinet wall and at least 30mm space between adjacent drives.

- The D2109 must have at least 8mm horizontal space between itself and the cabinet wall, and at least 15mm space between adjacent drives.

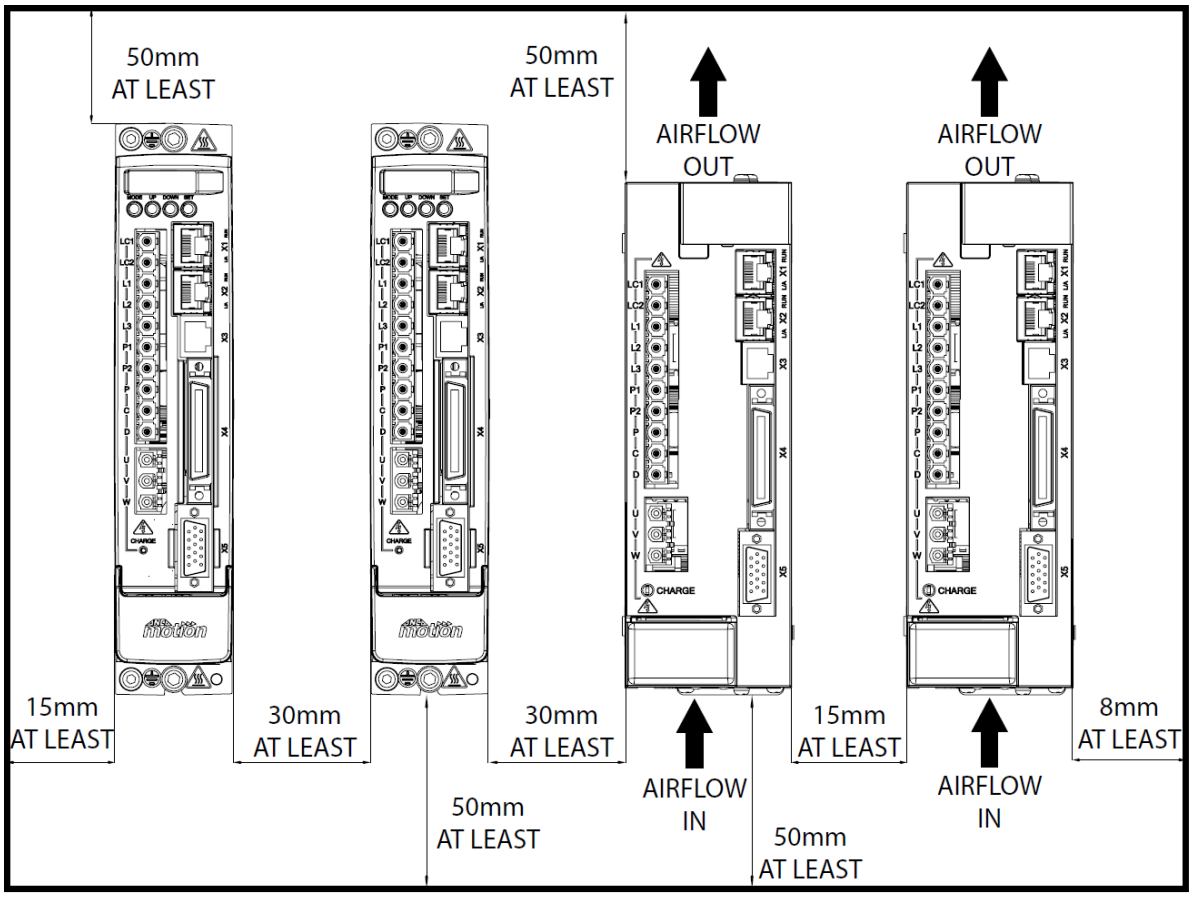


Figure 4-1 Mounting clearance requirements

If armature termination brackets are required to be fitted for EMC compliance, refer *to 6.7.2.1 Cable Shielding,* for fitting instructions.

Refer to *10.5 Environmental Specifications* for further requirements.

4.4 Installation

4.4.1 Power Isolation

DANGER HIGH VOLTAGE - The working DC bus is live at all times when power is on. The Main Isolator feeding the drive must be switched to the **off** position at least 15 minutes before any work is commenced on the unit. The operator must check the bus voltage with a tested working voltage measuring instrument prior to disconnecting any connectors or opening the DC Bus terminal cover. The red LED indicator on the front of the drive which indicates that there is charge remaining in the drive is only to be used as an aid to visual troubleshooting. It shall not be relied on as a means of safety.

Caution: The drive must be installed with an upstream circuit breaker that is rated appropriately depending on the model of AMD2000 drive being installed. Refer *to 6.6 Power Disconnect and Protection Devices* for more information.

Power isolation is required to prevent risk of electric shock during maintenance and assembly operations. Ensure isolation switches and isolation circuit breakers meet the requirements and applicable safety regulations of the region of operation. An appropriate approval for switches is IEC 60947-2 and for circuit breakers IEC 60947-3. The drive STO function DOES NOT isolate power from any part of the drive. Turn the Main Disconnect mains isolator switch to the Off position and follow the appropriate lockout procedure when installing the drive.

4.4.2 Mounting a Drive

Refer to section *10.6 Dimension Drawings* for drive dimensions and mounting hole positions.

STEP 1

Drill and tap 2 x M5x0.8P holes to suit hole pattern described in section *10.6 Dimension Drawings.* Overlap the drive onto the drilled holes to ensure that the hole positions are correct. The sheet metal panel should be a minimum 3mm thick.

STEP 2

Fit one of the M5 mounting screws partially into the lower drilled and tapped hole so that the majority of the screw thread is evident (A).

STEP 3

Position the drive so that the holes with the heat sink line up with the holes in the cabinet. There is an open slotted hole at the bottom of the heat sink. Insert the drive so that the screw fits within the open slotted hole (B) for location and then pivot the drive onto the cabinet (C).

STEP 4

Secure the drive to the cabinet by fitting the remaining M5 mount screw into the upper mounting hole to complete the mounting to the electrical cabinet. Tighten both M5 mounting screws (D & E) to maximum torque of 5Nm.

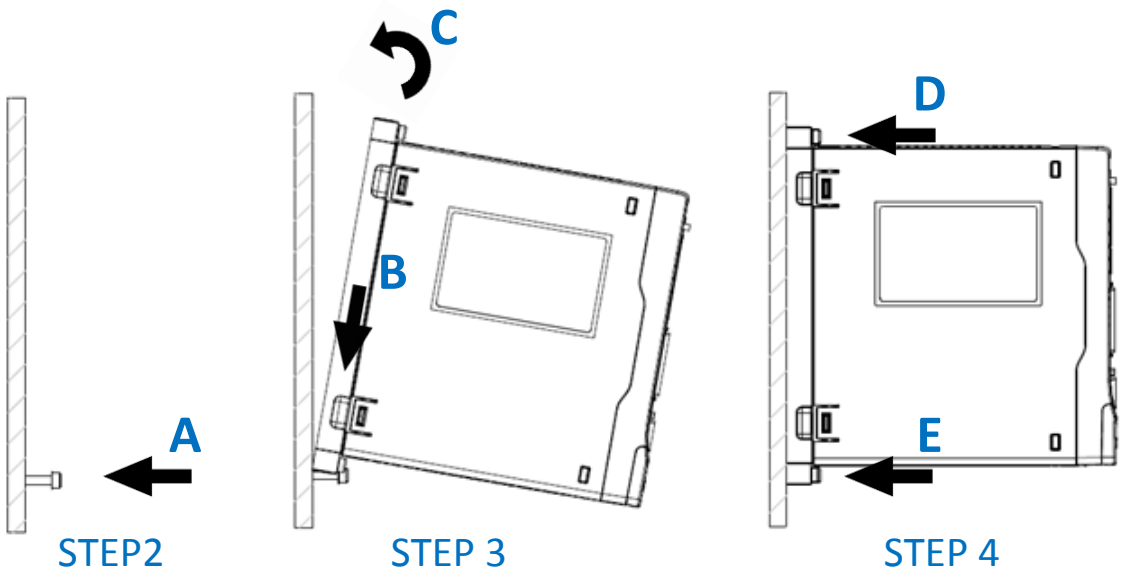


Figure 4-2 Mechanical Mounting of AMD2000 D2103 Servo Drive

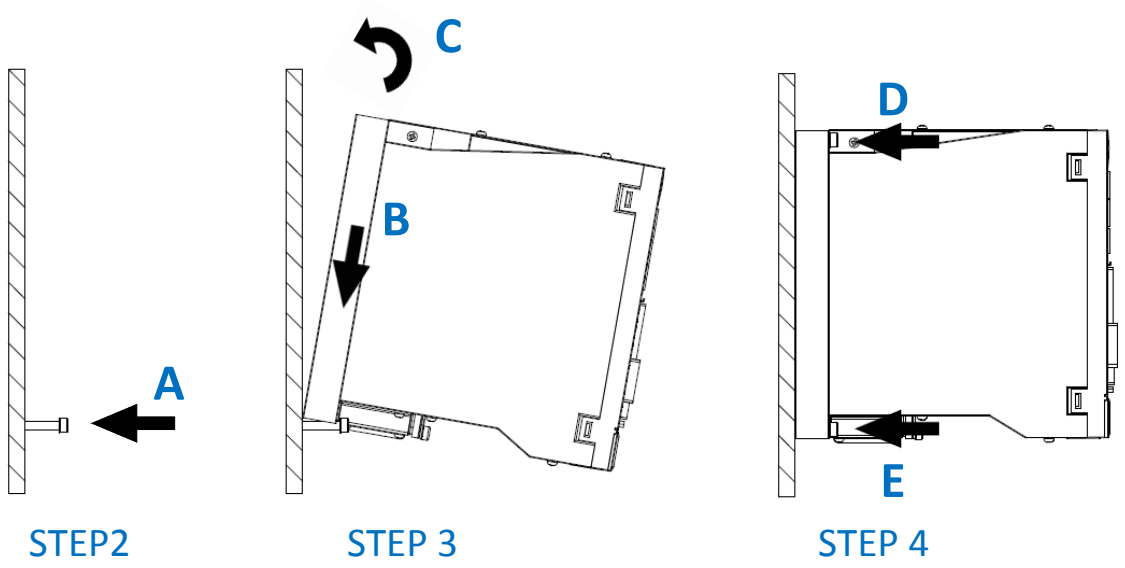


Figure 4-3 Mechanical Mounting of AMD2000 D2109 Servo Drive

STEP5

Connect appropriate electrical cables to complete installation as per section *5 Planning the Electrical Installation* and *6 Power Wiring*.

4.4.3 Un-Mounting a Drive

Ensure mains power has been *isolated from the drives* (see *4.4.1 Power Isolation* above).

STEP 1

Unplug the cables from the front of the drive to be un-mounted by carefully working the plugs from their sockets.

STEP 2

Follow steps 4 through to 2 of section *4.4.2 Mounting a Drive* in reverse order.

5 Planning the Electrical Installation

5.1 What this Chapter Contains

This chapter contains information that is useful in planning the electrical installation of the servo drives:

- Motor & Drive Compatibility
- Electrical Isolation and Protection Devices
- Cable Selection and Routing

The AMD2000 series of drives must be installed by a professional. A professional in this context is a person or organisation possessing the necessary skills and qualifications relating to the installation and/or commissioning of power drive systems, including their EMC aspects.

5.2 Motor and Drive Compatibility

Ensure that the AMD2000 drive and the AC motor intended for use are compatible according to their respective allowable limits of operation. For example, the AMD2000 uses PWM to apply power to the motor. The insulation stresses encountered using PWM will typically be higher than those experienced in non-PWM powered motor applications.

Warning: These drives are specifically for use ONLY with induction motors and PMSM motors rated for operation on a PWM inverter power supply.

Refer to *10.4.2 Digital servo drive* and *11.2.2 Motor Electrical Information Summary*

5.3 Power Supply Disconnecting Device

A mains disconnecting device must be connected between the AC power source and the AMD2000 drive. This must conform to the requirements and applicable safety regulations of the region of operation. An appropriate approval for switches is IEC 60947-2 and for circuit breakers IEC 60947-3. Generally switches should be selected with a mechanism available to use a lock. The drive STO function DOES NOT isolate power from any part of the drive.

Refer to *6.6 Power Disconnect and Protection Devices* for more information.

5.4 Emergency Stop Devices

An Emergency Stop Device must be installed for safety reasons within easy reach of operators and maintenance personnel at all operator control stations and wherever deemed necessary. Please note that Emergency Stop Devices are NOT to be confused with the Safe Torque Off (STO) function contained within the drive. The STO may be used in such an Emergency Stop Device chain to provide a mechanism for stopping, but it is the responsibility of the machine integrator to construct the suitable Emergency Stop Device, whether utilising STO or otherwise.

For information regarding STO, refer to *7.4 Safe Torque Off (STO) Operation.*

5.5 Thermal Overload and Protection

5.5.1 Fan Operation

The D2109 utilises a fan to cool the drive during operation. The fan will perform a self-test for 10 seconds each time the drive is powered on or the motor is enabled. Under normal operation, the fan will be active when the drive's temperature exceeds a pre-set threshold.

5.5.2 Thermal Overload

The AMD2000 has a built in temperature sensor that will shut off the drive when the heat sink temperature reaches a temperature that would be unsafe for continuous operation of the power switching semiconductors in the drive. The software will report an error if this occurs. If this occurs please review the mechanical spacing advice and thermal de-rating curves provided by ANCA Motion. Check the ambient temperature of air going to the bottom of the heat-sink in your specific application under steady state conditions.

5.5.3 Motor Cable Short-circuit

The AMD2000 contains features designed to protect the drive, motor and motor cable in the event of a short-circuit. The motor cable must be of the required specifications with respect to the current rating of the drive as a pre-requisite. There are two “layers” of protection in the AMD2000.

First protection layer – This is the instantaneous overcurrent protection implemented in the Firmware of the Drive. In many instances, output short-circuits are captured by this feature, though not all, depending on the dynamics and configuration of the fault. This protection can also be tripped by other abnormal output conditions related to uncontrolled output currents. The instantaneous trip levels are:

- 11.75A for D2103 (accompanied by E0308 “Instantaneous Current Limit Exceeded”)
- 23.75A for the D2109 (accompanied by E0308 “Instantaneous Current Limit Exceeded”)

Second protection layer – This is the instantaneous overcurrent protection implemented in the Output Power Stage of the Drive. For short-circuits that are not captured by the FIRST protection layer, the Power Stage relies on this SECOND protection layer for safety. The instantaneous trip levels are:

- 16A (typical) for D2103 (accompanied by E0004 “Power Stage General Fault”)
- 72.7A (typical) for D2109 (accompanied by E0004 “Power Stage General Fault”)

5.5.4 Supply Cable Short-circuit

The power supply cable is required to be protected via circuit breakers according to local requirements based on cable size. Please refer to the relevant standards or legislation for the region of operation. An appropriate standard for circuit breakers would be IEC 60947-2. Refer to section *6.6 Power Disconnect and Protection Devices* for more detail.

5.5.5 Motor Thermal Protection

The AMD2000 can monitor long term current usage to ensure it does not exceed the continuous current rating of the motor. However, the drive does not support motor thermal sensor based temperature monitoring. If protection against motor thermal overload is necessary, the user must supply a thermal fuse according to the maximum safe operating temperature of the motor being protected.

Please refer to sections *6.10 Motor Thermal Switch*, *6.11 Motor Thermal Sensor* and *6.12 Motor Thermal Estimation* for various ways Motor Protection can be incorporated in an application.

5.5.6 Brake Resistor

The AMD2000 drive does not have an internal protection mechanism for the internal regeneration resistor, therefore calculating if the internal regeneration resistor is sufficient and if an additional regeneration resistor is required is paramount. Failure to do this and provide evidence of these calculations may result in burning out the resistor and voiding the warranty of your drive.

Please refer to sections *10.4.5 Regenerative Braking* and *10.9 Regeneration Resistor* for additional information.

5.6 Power Cable Selection

The power supply and motor cables must be selected according to regional regulations as well as usage and EMC requirements.

The power supply cables must be rated for at least 300V AC. The cables must be rated to withstand the expected temperature rise due to the current passing through them, given the conductor diameter, conductor material and installation environment. Such a decision is governed by local installation regulations.

To comply with EMC regulations, the cable length of the motor armature cable must not exceed 15m. The cable must be shielded and the shield must be connected to earth at both ends. Shielded motor cables should be used with 360 degree saddles to connect the shield to an appropriate low impedance radio frequency earth. At the drive end, the armature shield must be connected directly to the drive earth point. It is highly recommended that an ANCA Motion shielding bracket be used. Please refer to section *6.6 Power Disconnect and Protection Devices* for recommended wire gauges.

Refer to *6.6 Power Disconnect and Protection Devices, 10.4 Electrical Specifications* and *11.3 Cables* for further information.

5.7 Control Cable Selection

It is strongly recommended that double shielded twisted pair cables (one individual shielded pair per signal) be used for both analogue and digital control signals. However, single shielded twisted multi pair cable may be used for low voltage digital signals if required. Analogue and digital signals should be run in separate cables where possible. A common return path should not be used for different analogue signals. Low and high voltage signals should never be run in the same cable.

5.7.1 Motor Feedback Wiring

In addition to the recommendations below, always ensure the directions given by the encoder manufacturer are followed.

Signal type	Recommendation	Comment
Outer shield	Shielded length of cable	Required in ALL cases to be present and 360 degrees clamped to back shell at both ends of cable
Differential analogue	Twisted Pair > 0.14mm2 Shielded length of cable	Impedance of 120Ω (100Ω also acceptable)
		Inner shields should be terminated to 0V of X5 at AMD2000 Series Servo Drive end ONLY. If not possible, terminate to back shell of X5 at AMD2000 Series Servo Drive end ONLY.
Differential digital	Twisted Pair > 0.14mm^2	Impedance of 120 Ω (100Ω also acceptable)
Power	> 0.5mm^2	Shielding is optional but recommended when using analogue signals. Terminate at the same point as analogue shield(s) if possible, otherwise terminate to back shell at both ends
Length	<= 10m	

5.7.2 EtherCAT Wiring

Signal type	Recommendation	Comment
Cable	Cat 5e or above	Screened, un-shielded twisted pair (F/UTP or SF/UTP), with 8P8C modular connectors. 100m maximum.

5.8 Cable Routing

There are three main categories of cabling for the drive discussed in previous sections.

- **Motor cables:** connecting motor and drive, these supply power to/from the motors.
- **Control cables:** returning information from the motors to the drives (e.g. Encoder info or temp info) or running information between drives or to other control units on the machine (e.g. Relays to/from master controllers).
- **Power supply cables:** connecting power supply unit and drive, this supplies power to/from the drives.

Care should be taken to avoid electromagnetic interference and coupling between cables. It is best practice that all three categories of cabling be routed separately. Power and motor cables should be separated (as much as practical) by at least 300 mm, whereas motor and control cables should maintain at least 500 mm separation over the majority of their length. If control and power cables must cross, they should cross perpendicular (at 90 degrees) to one another.

It is recommended that 24 V and 230 V cables be routed in separate ducts. Where this is not possible, the 24 V cable should be appropriately insulated for 230 V.

6 Power Wiring

6.1 What this Chapter Contains

This chapter contains information related to connecting the drive electrically to the incoming mains, motor and brake as well as what to be mindful of such as:

- Checking Assembly Insulation
- Cable Connection and Earthing
- Power Conditioning
- Regenerative Brake Selection / Calculation

6.2 Checking the Insulation of the Assembly

Installed supply and motor cables must be tested for functioning insulation according to local regulations by using an insulation resistance tester at 500V.

The AMD2000 drive has input supply voltage surge suppression components fitted to protect the drive from line voltage transients typically originating from lightning strikes or switching of high power equipment on the same supply. When carrying out a HiPot (Flash or megger) test on an installation in which the drive is fitted, the voltage surge suppression components may cause the test to fail and potentially damage the drive. To accommodate this type of system HiPot test, the cables **must** be disconnected from the drive.

The cables to be disconnected and tested are: control voltage single phase supply (L1C/L2C), single-phase or three-phase supply (L1/L2/L3), inductor connector (P1/P2), brake resistor connector (P/C/D) and motor connector (U/V/W).

6.3 Mains Power Supply

The following components are required for connection to the mains supply:

- Isolation switch to allow correct isolation of the system from the power supply
- Circuit breakers to protect cables, filter and drive
- EMI filter and line reactor to limit EMI on the mains supply

The mains control supply (LC1, LC2) for the drive requires a single phase supply which can be either two phases from a 3 phase supply (100-240V line to line) or from a dedicated single phase supply (100-240V line to neutral).

The mains power supply (L1, L2, L3) can be either from two or three phases of a three phase supply (100-240V line to line) or a single phase supply (100-240V line to neutral).

The mains control supply can be linked to the mains power supply allowing power to be applied at the same time. External soft start circuitry is not required. The mains and control supply cables are terminated on the 10-way connector as shown in *Figure 6-2 Mains Control and Power Supply Connector* below.

Recommended strip length for wires into cage clamp style (push in spring type) connectors is 10mm. Note that these cage clamp connectors must be used with stranded wire without the use of ferrules. Acceptable lead dress is illustrated in *Figure 6-1 Wire Stripping.*

The EMI filter and line reactor are required for EMC compliance; refer to *6.5 Installations conforming to the EMC Directive* for details on the recommended EMC compliant installation.

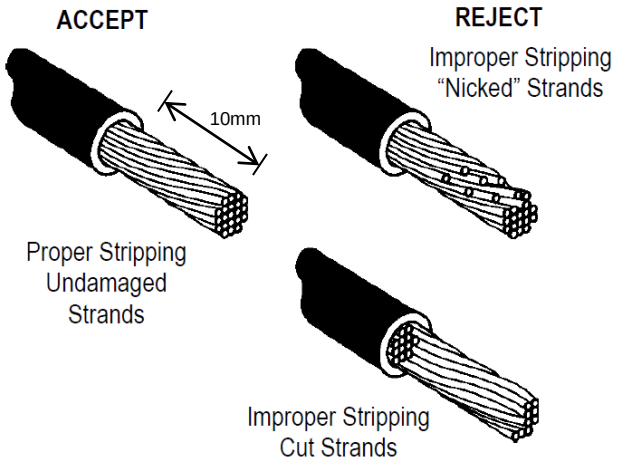


Figure 6-1 Wire Stripping

Warning: To avoid electric shock, ensure that the conductors are not frayed prior to insertion and that no strands are exposed. Please test to ensure that the conductors are clamped securely.

The AMD2000 series drives are suitable for use on supplies of installation overvoltage Category III, according to IEC 61800-5-1. This means they may be connected permanently to the supply at its origin in a building, but for outdoor machine installations closer to primary distribution supply (overhead cables etc.) additional over-voltage suppression (transient voltage surge suppression) must be provided to reduce Category IV to Category III.

AC Supply

PIN	SIGNAL
LC1	Control Voltage Single Phase Supply
LC2	Control Voltage Single Phase Supply
L1	Single/Three Phase Supply
L2	Single/Three Phase Supply
L3	Single/Three Phase Supply

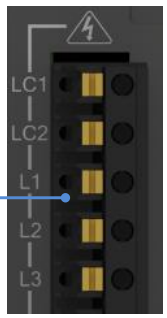


Figure 6-2 Mains Control and Power Supply Connector

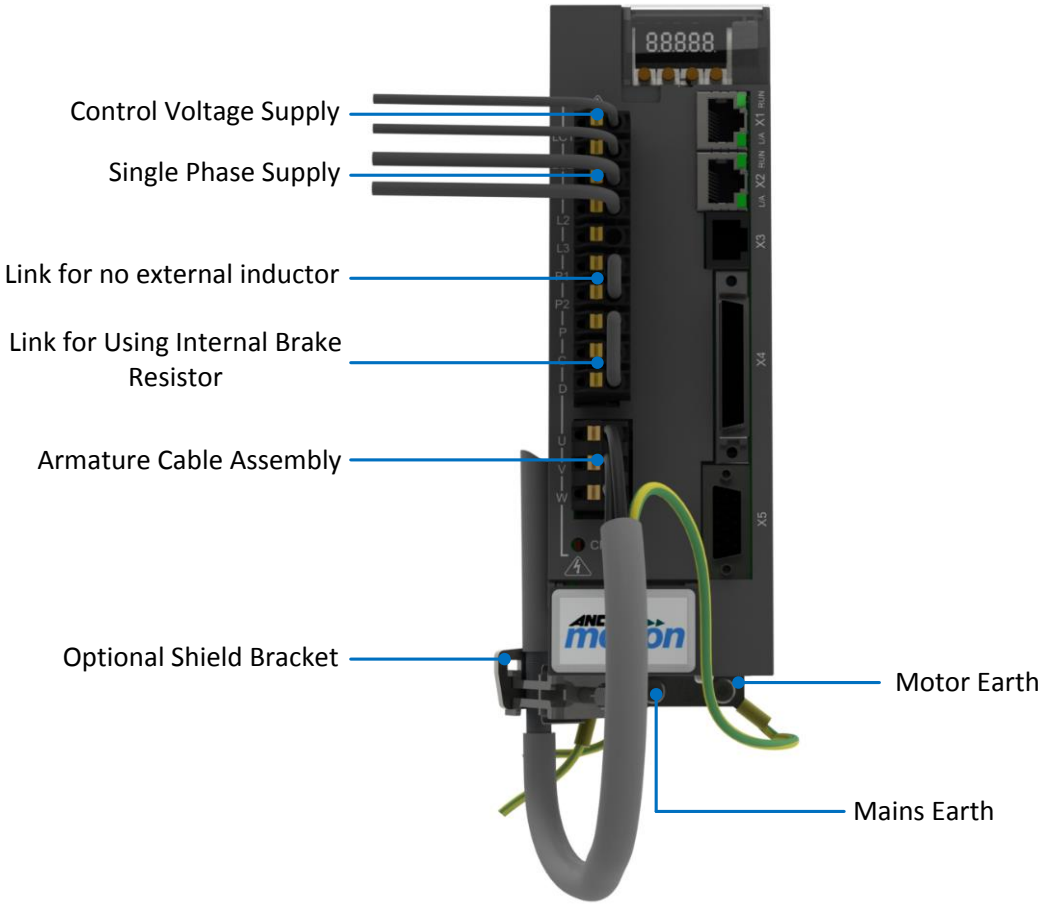


Figure 6-3 Typical View of Drive Connected for Single Phase Operation

Connector Link Wire Typical Specifications		
Drive	**Dimensions**	
3 A	14 AWG	2.5 mm^2
9A	14 AWG	2.5 mm^2

6.3.1 AC Voltage Supply

The AC supply voltage range must be within the limits specified in *Section 10.4 Electrical Specifications*

Mains supply voltage and frequency limits (NOTE: all voltages are line-to-line measurements)		
Drive input single phase voltage range	$U_{L1\text{-}L2}$	90-264V AC (100-240 ±10%)
Drive input three phase voltage range	$U_{L1\text{-}L2\text{-}L3}$	90-264V AC (100-240 ±10%)
Maximum input voltage to Protective Earth	$U_{L1,L2,L3,\text{-}PE}$	264V AC (240 ± 10%)
Nominal Input frequency	f_{LN}	50/60Hz

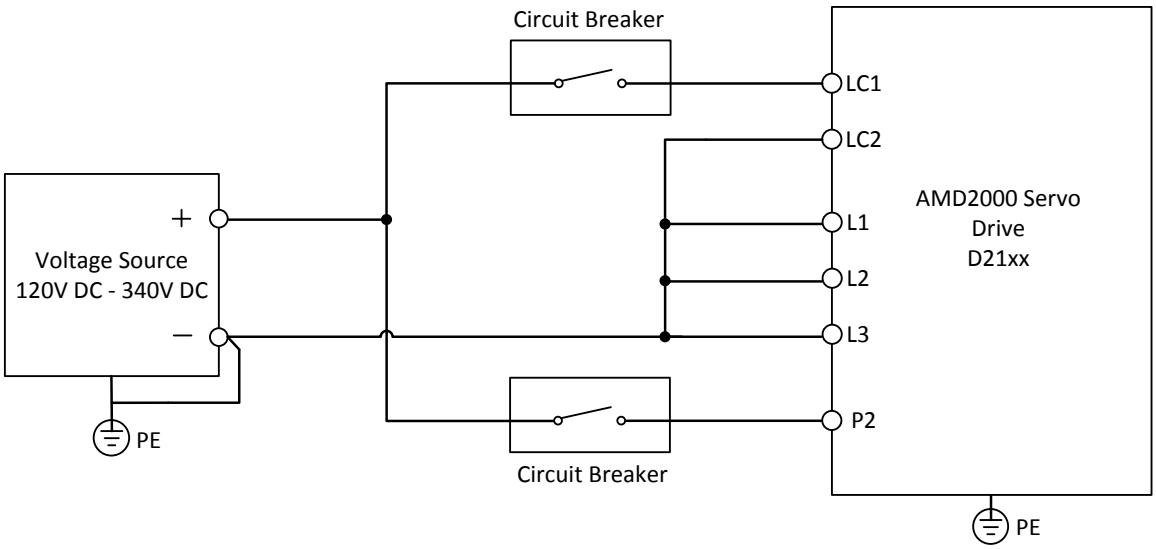
Operation at reduced supply voltage will require power de-rating as discussed in *10.8 Voltage and Temperature De-rating*.

Operation using single phase (and two phase) supplies instead of three phase supplies may also require power de-rating as discussed in *10.8 Voltage and Temperature De-rating.*

6.3.2 DC Voltage Supply

It is allowable to power the servo drive from a DC voltage source of equivalent voltage to the normal AC voltage input range. This is a range of 140V DC to 340V DC.

Connection of DC voltage should be as per the diagram below. Care should be taken to ensure the polarity is correct.



Warning: DO NOT install a link between P1 and P2 when operating on DC voltage supply

If the voltage source is not current limited (such as a battery bank) then a DC rated circuit breaker must be installed. If the voltage source is current limited (such as a DC-DC converter) then no circuit breaker is required.

If the available voltage is not sufficient, such a 12V battery, then a step up converter can be used.

When running from an isolated DC source the negative or 0V terminal can be deemed as “ground” and the drive chassis should be bonded to it.

6.3.3 Connection of drives to grounded systems (TN or TT)

The AMD2000 series drive is designed to operate with grounded TN & TT systems where the three phase supply is from a transformer with a grounded star point. With TN & TT systems any drive, motor or wiring ground fault generates substantial currents which must be quickly interrupted with circuit breakers in the mains supply as specified in *6.6 Power Disconnect and Protection Devices.* The AMD2000 requires appropriate circuit breakers for protection.

No separate connection for a neutral is provided, but in single phase supplies the neutral can be connected as a phase input to L2/LC2.

6.3.4 Connection of drives to non-grounded systems (IT)

Warning: It is not recommended that the AMD2000 series drive be connected to a non-grounded IT system, as it is no longer reliably electrically safe. Proper function of the drive is reliant upon an input supply that is ground referenced.

6.3.5 Harmonics and reactive power compensated supplies

The drive input diode bridge is a non-linear load to the mains supply and generates low frequency harmonic effects in the frequency range up to 9 kHz. The harmonics can be reduced to acceptable levels with the addition of an inductor (reactor) as discussed in *6.5 Installations conforming to the EMC Directive.* The non-linear currents cause non-sinusoidal voltage drops across the internal resistance of the mains supply transformer and therefore distort the voltage at the point of common coupling (PCC). This may affect other equipment connected at the PCC, especially if multiple drives are connected from same supply. Calculation of the harmonics and voltage distortion is site specific.

In multiple drive installations the harmonic currents may affect power supplies equipped with reactive power compensation capacitors as resonances excited by the harmonics will occur at relatively low frequencies. Therefore, it is strongly recommended that power compensation capacitors be fitted with reactor protection to prevent harmonic resonances.

6.3.6 Residual current-operated protective (RCD) protection

Residual current-operated protective devices (RCD) provide additional protection for detection of insulation faults where current is no longer contained in power conductors.

- It is only permissible to use delayed tripping, selective AC/DC-sensitive residual-current circuit-breakers, Type B.
- Parts of the electrical equipment and machine that can be touched are integrated in a protective grounding system.
- If an external EMC filter is used, a delay of at least 50ms should be incorporated to ensure spurious trips are not seen.
- The leakage current is likely to exceed the trip level if all of the phases are not energized simultaneously.

Caution: Under fault conditions it is possible for a DC current to be present in the protective earthing conductor. This DC current can reduce the ability of a type A or AC type RCD to trip.

Warning: These drives designed for category C3, and are not intended to be used on a low-voltage public network which supplies domestic premises.

6.4 Grounding

A grounding system has three primary functions: safety, voltage-reference, and shield termination. The safety function is required by local regulations and is designated as the Protective Earth. Signal and control circuits are typically grounded at various points with the ground forming the common voltage reference. Shields on cables reduce emissions from the drive for CE compliance and protect internal circuits from interference due to external sources of electrical noise.

The Protective Earth (PE) Connection from the mains supply eliminates shock hazards by keeping parts at earth potential. The PE also conducts fault currents to earth ground until the safety device (circuit breaker) disconnects the drive from the mains.

Symbol for Protective Earth (PE)

The mains supply protective (PE) cable must have a cross sectional area equal to or greater than 10mm^2 (copper conductors), or use a second earthing conductor of the same cross-sectional area as the original earthing conductor due to the drive leakage current.

Warning: Earth leakage current in the protective earthing conductor exceeds 3.5 mA AC for both the D2103 and D2109.

On the D2103, the mains PE is connected to 2 x M4 screw terminals at the bottom end of the drive heat sink area via the supplied M4 screws.

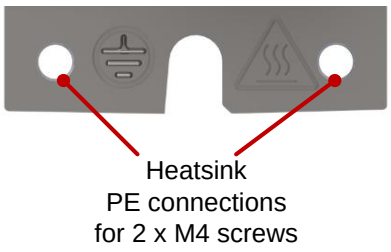


Figure 6-4 D2103 PE Terminals

On the D2109, the mains PE is connected to 2 x M4 screw terminal at this bottom end of the drive heat sink area via the supplied M4 screws.

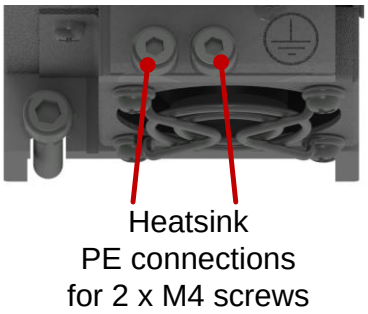


Figure 6-5 D2109 PE Terminals

In multiple drive installations, each drive must be individually wired to a common PE point. Do not daisy chain PE connections from one drive to the next.

The AMD2000 drive is designed to be installed on an unpainted metal gear tray e.g. galvanized surface which forms an equipotential bond to all equipment mounted on the same gear tray. This minimizes voltage differences to all grounded connections and enhances the immunity of equipment against conducted and radiated RF disturbance. The gear tray must be connected to the supply PE, and is designated the Chassis Earth.


Symbol for Chassis Earth

PE connections using the optional armature bracket are described and illustrated in *6.7.2.1 Cable Shielding.*

6.5 Installations conforming to the EMC Directive

EMC stands for Electromagnetic compatibility. It is the ability of electrical/electronic equipment to operate without problems within an electromagnetic environment. The equipment must not disturb or interfere with any other product or system within its locality. Variable speed drives are a source of interference, and all parts which are in electrical or airborne connection within the power drive system (PDS) are part of the EMC compliance.

The drive interference is generated from the output voltage waveform which is a rapidly changing voltage waveform (Pulse Width Modulation). The voltage transitions present on all motor cables and motor windings induce parasitic common mode currents (I_{LEAK}) in the stray capacitance of the motor and cable system. See *Figure 6-6 Common Mode Noise Current Paths in a Drive System.* The common mode currents return to the drive inverter by the lowest available impedance paths which must be carefully managed to prevent interference voltages being generated in other equipment connected to the same earth system. The internal common mode capacitors of the drive provide one return path (I_{DC}) to the drive, and the EMI filter provides another return path via the drive mains input.

To ensure the installation conforms to the EMC Directives, both of the following actions must be completed by the installer;

1. Select appropriate EMC components, and
2. Implement appropriate wiring setups to limit high-frequency harmonic effects.

Warning: EMC related performance, however, can still be influenced by factors not covered by the configuration details supplied in this section of the user guide. It is difficult to consider all necessary wiring and conditions of the equipment particular to all possible customer needs. For this reason, the EMC conformance of the system as a whole must be confirmed by customer in accordance to the appropriate standards for their application and market.

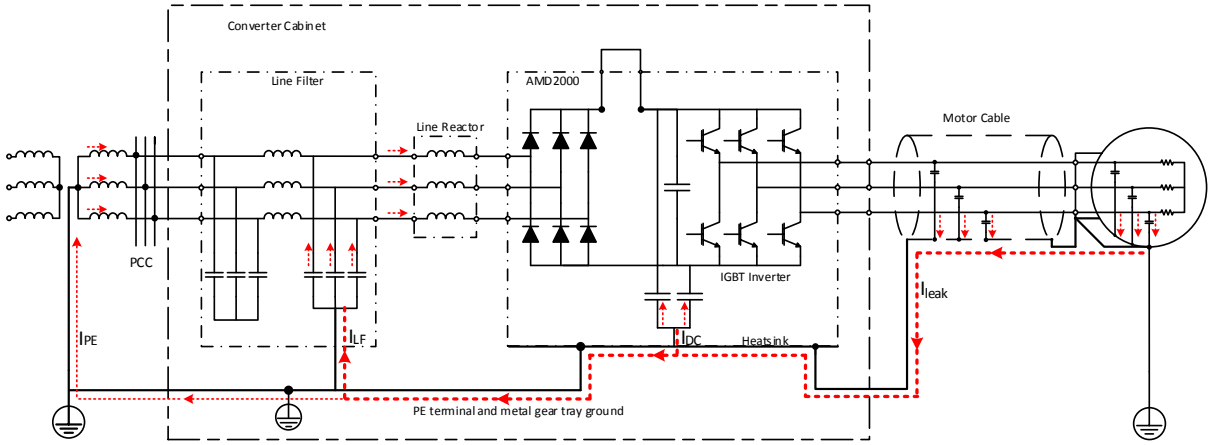


Figure 6-6 Common Mode Noise Current Paths in a Drive System

6.5.1 For 3 phase supply system wiring

Figure 6-7 shows the recommended EMC components for wiring of a 3 phase supply system. An EMI filter and a 3 phase line reactor are installed on the input power side. P1 and P2 should be linked using a smallest feasible length wire at full drive current rating.

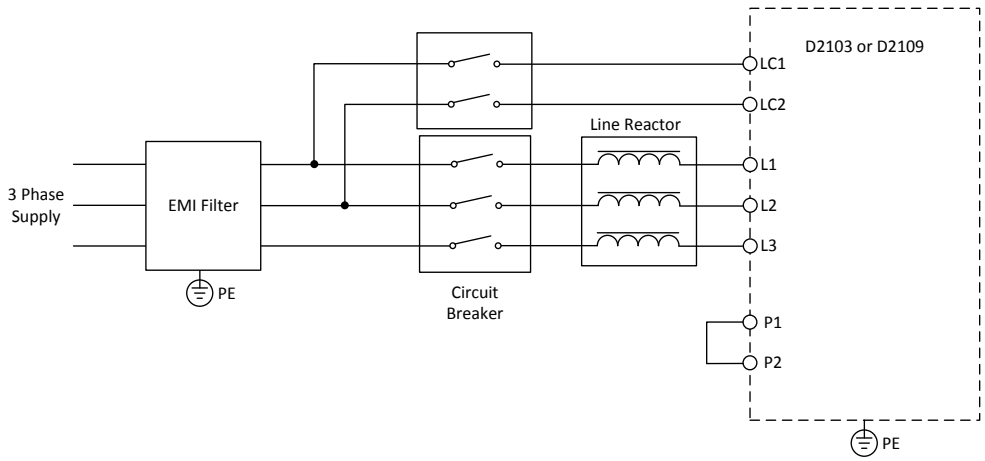


Figure 6-7 EMC components installation for a 3 phase supply

Recommended EMC components for a 3 phase supply		
EMI Filters	D2103 3 phase supply	Schaffner 3 phase 10A EMI Filter FN3270H-10-44
	D2109 3 phase supply	Schaffner 3 phase 20A EMI Filter FN3270H-20-44
Line Reactors	D2103 3 phase supply	3.06mH, 7.6A Hammond Power Solutions CRX07D6AC Or equivalent
	D2109 3 phase supply	1.64mH, 14A Hammond Power Solutions CRX0014AC Or equivalent

6.5.2 For 1 phase supply system wiring

Figure 6-8 shows the recommended EMC components for wiring of a 1 phase supply system. An EMI filter is installed on input power side and a DC choke is installed on the DC BUS side between P1 and P2.

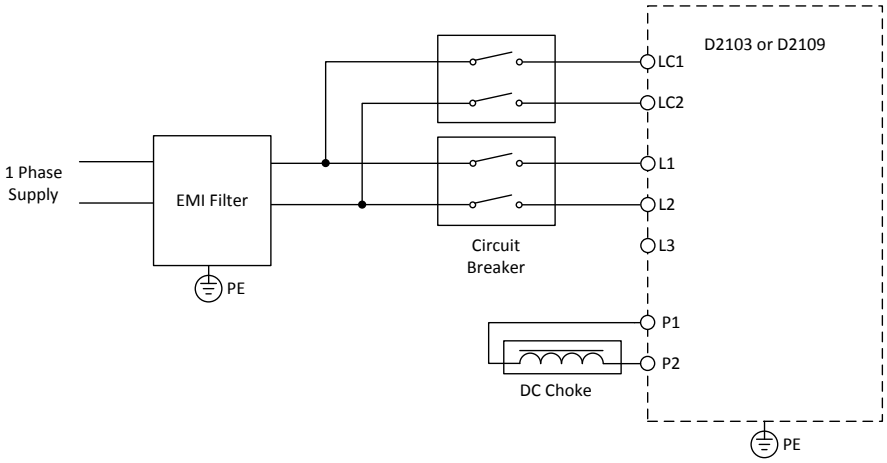


Figure 6-8 EMC Components Installation for a 1 Phase Supply

Recommended EMC Components for a 1 Phase Supply		
EMI Filters	D2103 1 phase supply	Schaffner Single-phase 8A EMI Filter FN 350-8-29
	D2109 1 phase supply	Schaffner Single-phase 20A EMI Filter FN 350-20-29
DC Chokes	D2103 1 phase supply	10mH, 5A Hammond Power Solutions 159ZJ Or equivalent
	D2109 1 phase supply	5.46mH(*), 14A Hammond Power Solutions CRX0014BC Or equivalent

(*) – The 5.46mH 14A DC choke for the D2109 is a 3 phase line reactor (2.73mH, 14A); *Figure 6-9* illustrates the wiring.

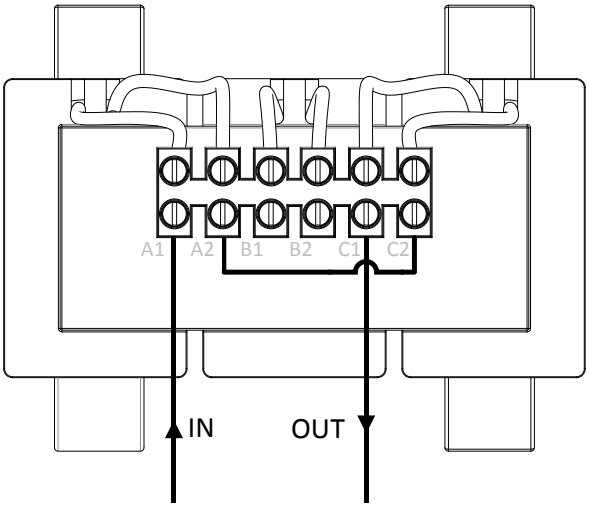


Figure 6-9 Wiring needed to make a DC Choke from a 3 Phase Line Reactor

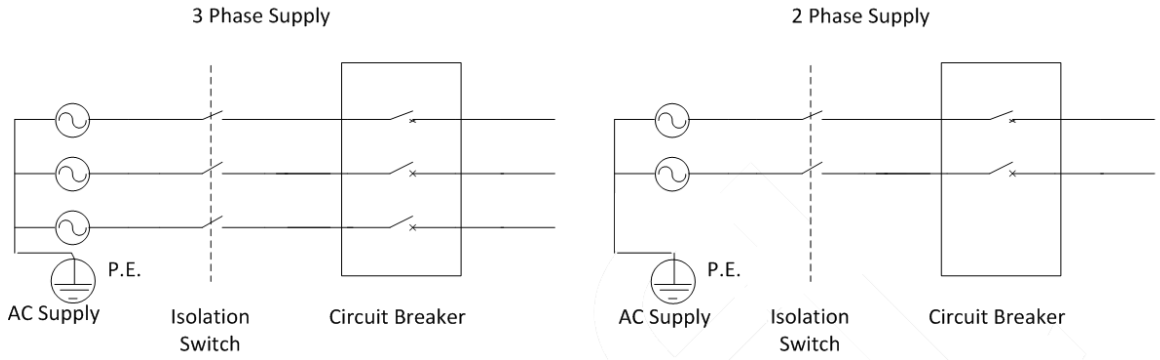
6.5.3 Installation guidelines of EMC components

- Install the EMC components as close as possible to the drive.
- A shielded cable is recommended if the distance between the EMI filter and the drive exceeds 30cm.
- Minimize cross talk of “clean” lines (mains supply to filter input) due to “noisy” power cables by careful routing and cable segregation.
- Ensure EMC components mounted on a galvanised steel or bare aluminium panel with a minimum thickness of 3mm to provide a low impedance return path. Otherwise, connect the EMC components to a gear tray with minimal length flat copper braid strap.
- Connect EMC components to PE for safety requirements, but note that the PE cable does not provide a low impedance return path for common mode currents due to its cable length and the skin effect of conductors. Best EMC equipotential bonding is achieved using careful mounting or use of braided earth straps (refer to *6.4 Grounding*).
- Minimize motor cable length, and use correctly shielded motor cables (refer to *6.7.2 Motor Power Cable Installation*). For longer cable lengths a ferrite ring on the drive output will reduce EMC noise.
- Ensure that the EMI filter is always used with a line inductor or DC choke that reduces rms currents, otherwise these may lead to currents exceeding the filter’s rating.

6.6 Power Disconnect and Protection Devices

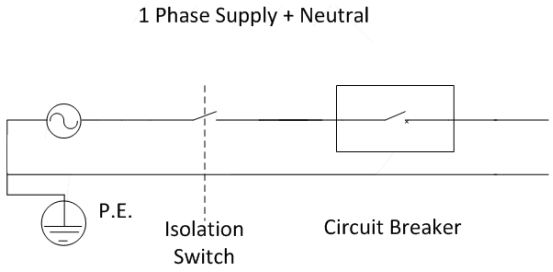
Install a manually-operated mains supply disconnecting device between the AC power source and the drive. The disconnecting device must be of a type that can be locked to the open position for installation and maintenance work and must comply to Safety of Machinery standard EN 60204-1 and local regulations.

The AMD2000 must have suitable input power protection on each phase input. This must conform to the requirements and applicable safety regulations of the region of operation. An appropriate approval for switches is IEC 60947-2 and for circuit breakers IEC 60947-3.



When using 2 phases of a 3-phase supply, each phase must have suitable protection and the voltage must not exceed the rated input voltage.

When using a single phase supply with a Neutral conductor, protection is only required on the supply phase.



Recommended AC circuit breakers and supply wire sizes					
Drive Type and current output rating (A rms)	**AC supply**	**Max. Input Current (rms)**	**Circuit breaker (C-type)**	**Minimum Ø wire gauge**	
				AWG	**mm²**
AMD2103, 3A	1Φ power	5A	6A	16	1.5
	3Φ power	5A	6A	16	1.5
	1Φ control	0.5A	2A	20	0.5
AMD2109, 9A	1Φ power	13A	16A	14	2.5
	3Φ power	13A	16A	14	2.5
	1Φ control	0.5A	2A	20	0.5

Recommended DC circuit breakers and supply wire sizes					
Drive Type and current output rating (A rms)	**DC supply**	**Max. Input Current DC**	**Circuit breaker DC rating (C-type)**	**Minimum Ø wire gauge**	
				AWG	**mm^2**
AMD2103, 3A	Power	3A	4A	16	1.5
	Control	0.5A	1A	20	0.5
AMD2109, 9A	Power	9A	10A	14	2.5
	Control	0.5A	1A	20	0.5

Note: All wire sizes are based on 75 °C (167 °F) copper wire. Use of higher temperature cable may allow smaller gauge wires. Size cables to conform to the local electrical installation regulations.

- The mains supply wire should be used for the following power connections:
  - AC supply to external EMC filter
  - AC supply (or external EMC filter) to drive
- Cable sizes are a guidance only as installation methods such as grouping, length, use of conduits and ambient temperature may affect current capacity
- Where more than one cable per terminal is used the combined diameters should not exceed the maximum.
- The terminals are suitable for both solid and stranded wires.
- Circuit Breakers must be thermal magnetic type.
- Motor cables should have the same wire gauge as 3 phase mains supply.

6.7 Motor Connections

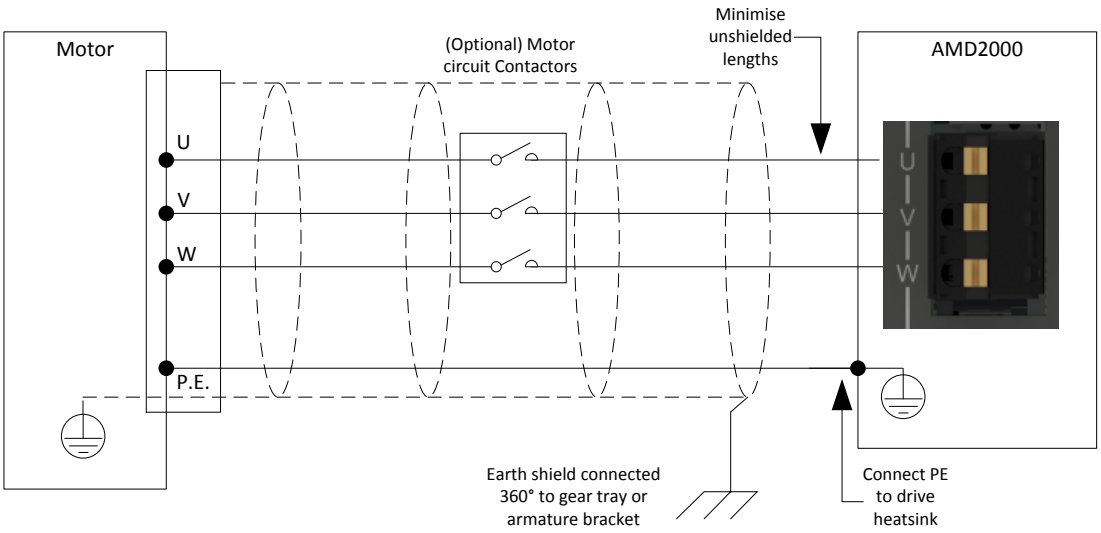


Figure 6-10 Motor connections and shielding

Connect correct phase wires (U, V, W) to the servo motor to ensure the servo motor operates correctly.

Do not connect AC mains power supply directly to the drive U, V, W terminals, otherwise damage may occur to the drive.

The PE ⏚ for the motor must be connected to the M4 screw terminal at one end of the drive heat-sink, preferably at the end closest to the armature motor connector. Do not connect directly to the mains supply protective earth as this will increase EMC noise.

6.7.1 Motor Circuit Contactors

A motor circuit contactor may be installed if required by local codes or for safety reasons. The motor circuit contactor isolates the motor fully from the drive to allow maintenance and form part of a safety system.

Ensure that shielding of the motor cable is continued on both sides of the motor circuit contactor as shown in *Figure 6-10 Motor connections and shielding*.

6.7.2 Motor Power Cable Installation

6.7.2.1 Cable Shielding

In order to comply with the EMC requirements and minimize effects to other equipment, motor cables and power supply cables from line filter AMD2000 drive must be used with shields. The cable shield minimizes electromagnetic noise which may be coupled into nearby conductors, and the shield provides a low impedance path for common mode noise currents back to the drive via EMC filter or drive common mode capacitors. *Figure 6-10 Motor connections and shielding* which illustrates the path of common currents. The gear tray layout and correct bonding of the shield in the cabinet is a critical component in managing EMC problems. The following guidelines must be followed.

- Cables between the inverter and motor must be shielded, and the shield grounded at both ends.
- Use motor cables with dedicated PE conductor(s). Do not use the shield as a PE.
- The shield clamping surface must be free of paint.
- Use specifically designed shield clamps. Do not use plastic ties.
- Select shield connections with low impedance in the MHz range.
- Shield clamps can be with or without mechanical strain relief
- Metallic components in the gear tray and cabinet must have a large surface area and should be connected to one another with a high level of RF conductivity.

6.7.2.1.1 D2103 Cable Shielding

Use an Armature Bracket in order to terminate the shielded cable assembly.

The Armature Termination Bracket assembly consists of the following parts:

- Armature Termination Bracket
- EMC Saddle Clamp
- 3 x M4 screws
- 1 x M6 screw

Please see *11.4.7 Armature Cable Shield* for bracket ordering details.

- Clamp the Armature Termination Bracket down as shown below using the 2 x M4 existing screws that came with the drive. Maximum tightening torque is 2.5Nm.
- Carefully remove the Armature cable sheath to expose the metal braid. Expose approximately 25mm of braid length.
- The position of the exposed braid is to coincide with the EMC Saddle Clamp and the metal bracket as shown below in order to provide sufficient contact for termination.
- Tighten the Saddle Clamp screw to 0.5Nm.
- Fit the armature plug into the armature connector on the drive.

- Ensure that the Armature Cable Earth wire is connected to an M4 ring lug using one M4 screw from the Armature Termination Bracket assembly kit, and connect to the bracket as shown below. Maximum tightening torque is 1.5Nm.
- The Armature Termination Bracket has been designed to allow the Protective Earth (PE) wires to be connected in two ways.
    a) Connection for two PE wires less than 10mm² Cu by using two M4 screws. Maximum tightening torque is 1.5Nm.
    b) A single PE wire if the conductor size is greater than 10mm² Cu by using a single M6 screw. Maximum tightening torque is 3Nm.

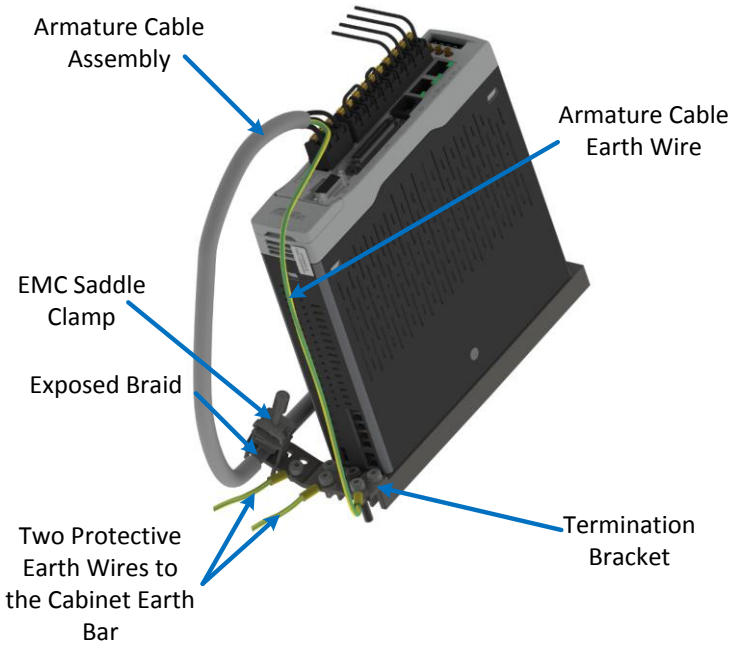


Figure 6-11 Armature Cable Shield Connection with 2 x PE wires

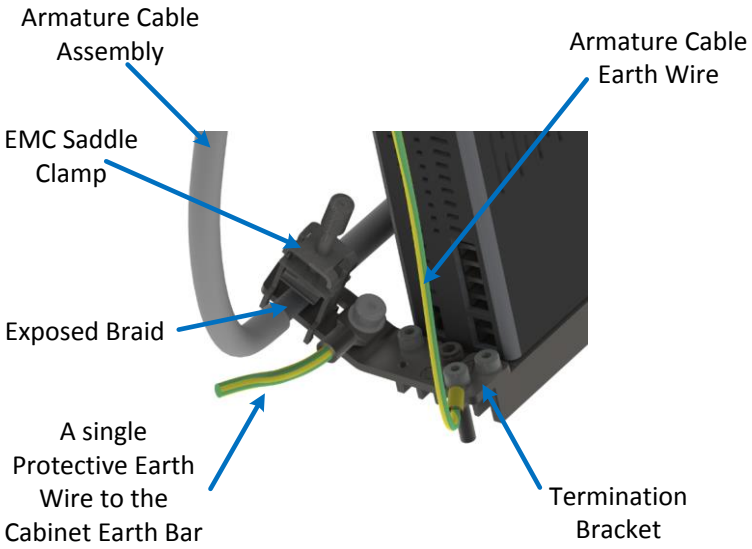


Figure 6-12 Armature Cable Shield Connection with 1 x PE wire

6.7.2.1.2 D2109 Cable Shielding

Use an Armature Bracket in order to terminate the shielded cable assembly.

The Armature Termination Bracket assembly consists of the following parts:

- Armature Termination Bracket
- EMC Saddle Clamp
- 3 x M4 screws
- 1 x M6 screw

Please see *11.4.7 Armature Cable Shield* for bracket ordering details.

- Clamp the Armature Termination Bracket down as shown below using the 2 x M4 existing screws that came with the drive. Tightening Torque 2.5Nm max.
- Carefully remove the Armature cable sheath to expose the metal braid. Expose approximately 25mm of braid length.
- The position of the exposed braid is to coincide with the EMC Saddle Clamp and the metal bracket as shown below in order to provide sufficient contact for termination.
- Tighten the Saddle Clamp screw to 0.5Nm as recommended by the manufacturer.
- Fit the armature plug into the armature connector on the drive.
- Ensure that the Armature Cable Earth wire is connected to an M4 ring lug using one M4 screw from the Armature Termination Bracket assembly kit, and connect to the bracket as shown below. Maximum tightening torque is 1.5Nm.
- The Armature Termination Bracket has been designed to allow the Protective Earth (PE) wires to be connected in two ways.
  a) Connection for two PE wires less than 10mm² Cu by using two M4 screws. Maximum tightening torque is 1.5Nm
  c) A single PE wire if the conductor size is greater than 10mm² Cu by using a single M6 screw. Maximum tightening torque is 3Nm.

See below for the interactions for the shielded armature termination.

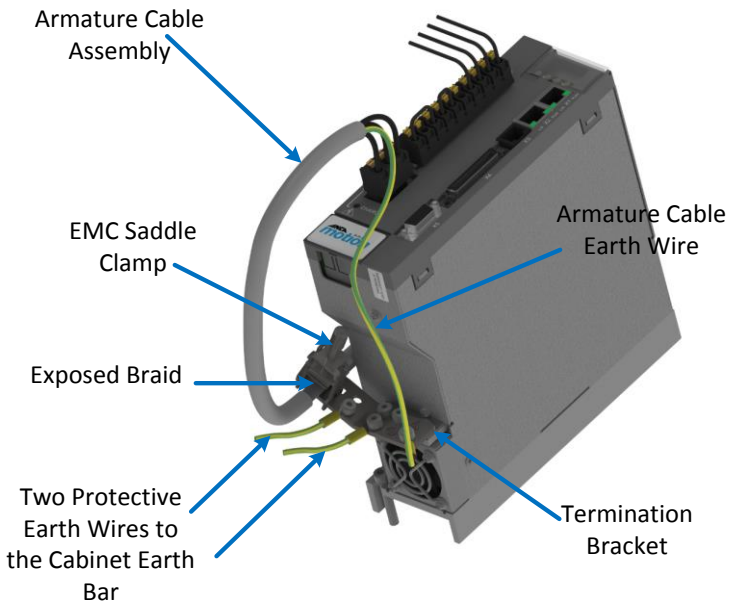


Figure 6-13 Armature Cable Shield Connection with 2 x PE wires

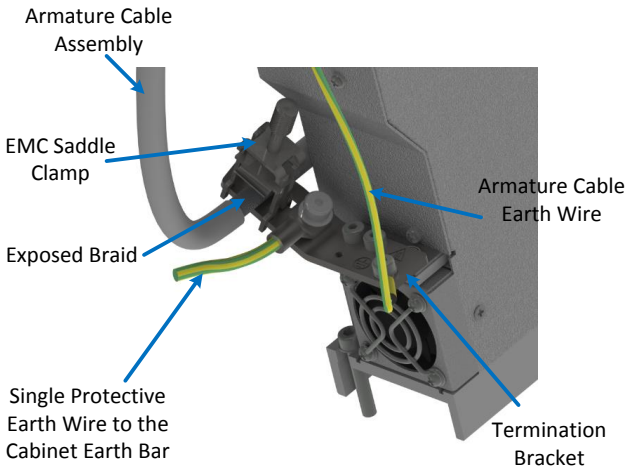


Figure 6-14 Armature Cable Shield Connection with 1 x PE wire

6.7.2.1.3 Continuation of Motor Power Cable Shielding

Depending on the motor connector type, the armature cable shielding at the motor end should be terminated in one of the following ways:

1. If the motor has a metal connector on the motor housing and the armature cable shield is terminated at this motor connector
    - Armature shielding will inherently be connected to the motor casing and no further work is required at the motor end of the armature cable.
2. If the motor connector housing is not metal or the armature cable shield is not terminated at the motor connector
    - Add a metal P-Clip or equivalent to the armature cable at a location that is close to the motor for earthing the shield.
    - In order to add this part to the Armature Cable, remove a sufficient amount of outer sheath in order to make direct contact with the exposed metal braid.
    - Ensure that the metal braid is not damaged in this process.
    - Affix the metal P-Clip to bare metal as close to the motor as possible, on the motor housing itself if possible. The shield is required to have a good electrical connection to the machine earth.

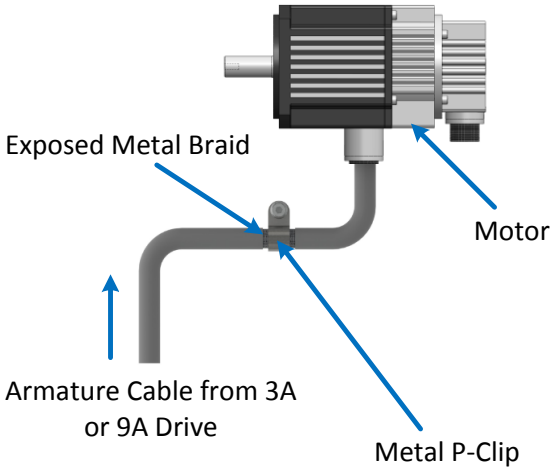


Figure 6-15 Armature Cable Shield Termination with metal P-Clip at Motor End

The below graphic shows a typical Earth Bar installation that may exist on the cabinet. Connect the Protective Earth wires to the Earth bar as shown. Each protective earth Wire will be from a drive in the cabinet.

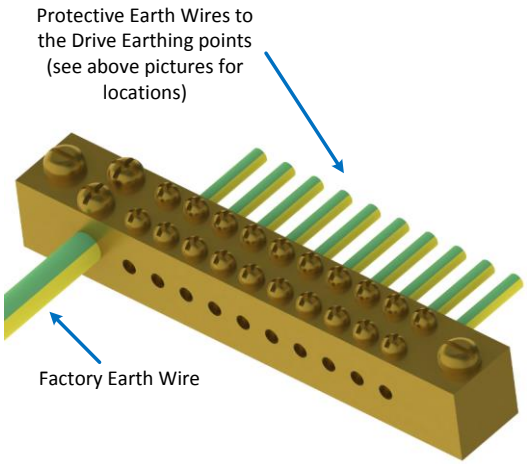


Figure 6-16 Use Star Topology to Connect Drive Protective Earth to Earth Bar

6.7.2.2 Cable Routing

In a drive system the return common mode currents flow through shields, cabinets, gear tray and earth wiring to create localized parasitic ground potentials, which may affect control signals using the ground as a common voltage reference. Careful planning of cable routing and location of shield grounds must be done to minimise influence of parasitic ground potentials, and ensure compliance with EMC requirements. The following guidelines must be followed.

- Physically separate “noisy” and “clean” cables at the planning stage. Pay special attention to the motor cable. The area around the shared terminal strip for the mains input and motor output is particularly at risk.
- All cable routing in an enclosure should be mounted as close as possible to gear tray or grounded cabinet walls; “free-floating cables” act as both active and passive antennae.
- Use twisted pair wires wherever possible to prevent interference from radiated common mode noise sources. Continue the twist as close as possible to terminals.
- Use shielded twisted pairs for analogue and control level wires exiting from the overall enclosure.
- Keep power and control wiring separate. Crossing at right angles is permitted, but no significant parallel runs should be allowed, and cables should not share cable trays, trunking or conduits unless they are separately shielded and the shields correctly terminated
- Avoid mixing pairs with different signal types e.g., 110 V AC, 230 V AC, 24 V DC, analogue, digital.
- If plastic trunking/ducting is used, secure it directly to installation plates or the framework. Do not allow spans over free air which could form an antenna.
- Keep shield pigtails as short as possible and note they are less effective than full clamping
- Allow no breaks in the cable shields.
- Earthing connections should be as short as possible in flat strip, multi-stranded or braided flexible conductors for low RFI impedance.

6.8 Drive Output Filters

6.8.1 Sinusoidal Filter

Sine-wave filters are designed to let only low frequencies pass. High frequencies are consequently shunted away which results in a sinusoidal phase to phase voltage waveform and sinusoidal current waveforms. Sine wave filters are recommended for the following applications:

- Reduction of motor acoustic switching noise
- Motors that are not “inverter rated” which have reduced insulation levels and can only accept sinusoidal inputs supplies
- Retrofit installations with old motors that are not “inverter rated”
- Motors that require reduced bearing currents to prolong motor life and reduce service intervals
- Step up applications or other applications where the frequency converter feeds a transformer

Note: Sine-wave filters must be selected for the drive switching frequency of 8kHz. Sinusoidal filters with nominal frequency higher than 8kHz cannot be used.

Standard sine wave filters are connected to the drive output as shown in *Figure 6-17 Motor Connections and Shielding with Standard Sinusoidal Filter*. For more demanding applications, sine wave filters with DC bus connections can also be used as shown in *Figure 6-18 Motor Connections and Shielding and DC Link Sinusoidal Filter*. There is an output voltage drop of approximately 5-10% across the sinusoid filter.

Configuration	Recommended Sinusoidal Filters*	Recommended EMC Filter Specs*		
		Rated Current	Typical motor Power Rating	DC Link Voltage (Max)
D2103 with no DC bus connection	3-phase 4A sine wave	4A	1.5kW	-
D2103 with DC bus connection	3-phase 4A sine wave	4A	1.5kW	850V
D2109 with no DC bus connection	3-phase 12A sine wave	12A	5.5kW	-
D2109 with DC bus connection	3-phase 12A sine wave	12A	5.5kW	850V

*Motor frequency range is from 0-200Hz for these filters

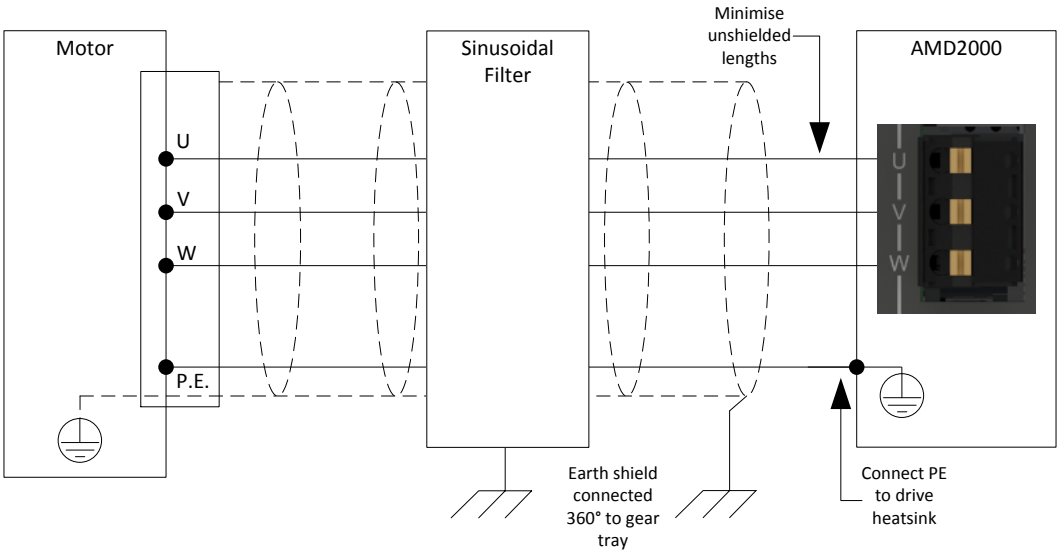


Figure 6-17 Motor Connections and Shielding with Standard Sinusoidal Filter

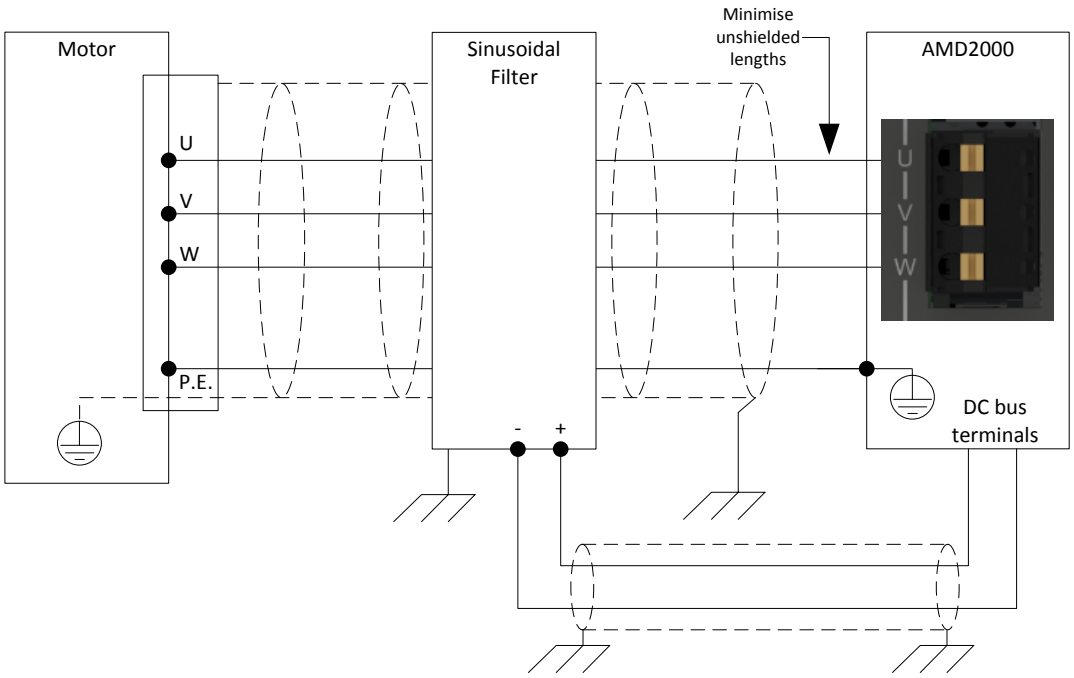


Figure 6-18 Motor Connections and Shielding and DC Link Sinusoidal Filter

6.8.2 du/dt Filter

The du/dt filters consist of inductors and capacitors in a low pass filter arrangement and their cut off frequency is above the nominal switching frequency of the drive. Compared to Sine-wave filters they have lower L and C values, thus they are cheaper and smaller, and have less voltage drop (approximately 0.5%). With a du/dt filter the voltage wave form is still PWM shaped but the current is sinusoidal. The reduced performance of the du/dt filter compared to the sinusoid filter makes it unsuitable for motor bearing current reduction and acoustic noise reduction.

6.9 Motor Brake Connection

Some motors require the use of a brake to prevent motor movement when power is removed. The motor's brake must be wired up to a relay which is controlled by the 24V digital output 1 (DO1), on connector X4. The relay must be wired with a protective fly-back diode as shown to prevent damage to the output circuit.

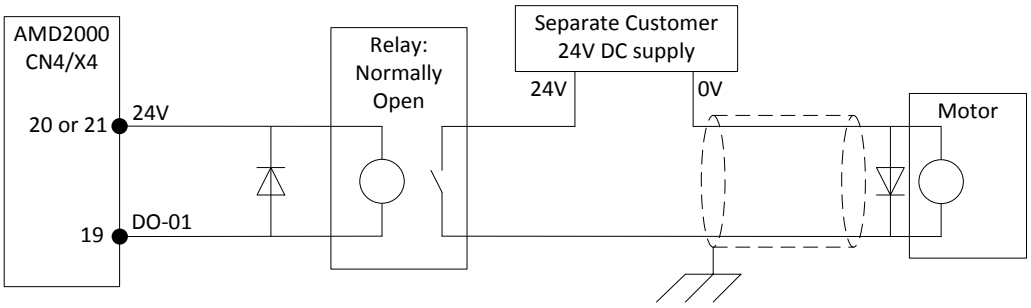


Figure 6-19 Motor Brake Interface Circuit

To engage the brake:

- The motor is brought to rest under normal control;
- The relay is deactivated, causing the brake to engage;
- The drive is disabled, removing power from the motor.

To disengage the brake:

- The drive is enabled;
- The drive applies power to the motor to hold position under normal control;
- The relay is activated, causing the brake to be disengaged.

The D21xx contains a configurable brake release delay after the motor is enabled to prevent undesired movement, refer to the *AMD2000 Series Servo Drive – CoE Configuration Guide* or *AMD2000 Series Servo Drive – SoE Configuration Guide* for more information. It is also sometimes necessary to include a small delay after the relay has been activated, before starting motion. This delay allows time for the relay contacts to engage and the brake to release.

The 24V DC power supply for the brake must be a separate supply as brake wires often carry noise, and generate a large voltage spike which may affect other devices connected to the brake supply. Do not use the D21xx 24V supply from X4 to power the brake. The separate 24 V DC supply used for the motor brake can also be used to power the relay in the thermal switch circuit.

6.10 Motor Thermal Switch

Some motors provide thermal switch to prevent the motor overheating. The motor's thermal switch must be wired up to a relay which generates a 24V digital input on connector X4. Any of digital inputs DI-01 to DI-08 may be used and DI-01 is shown in *Figure 6-20 Motor Thermal Switch Interface Circuit*.

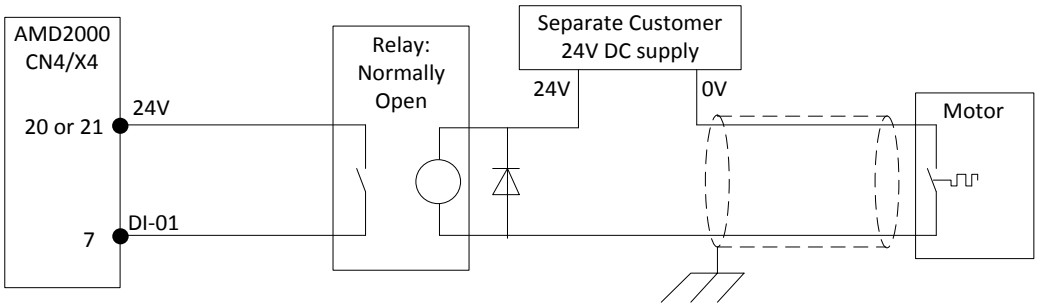


Figure 6-20 Motor Thermal Switch Interface Circuit

The 24V DC power supply for the thermal switch must be a separate supply as it can often carry noise that could cause erratic drive operation, and may not provide sufficient isolation. Do not use the D21xx 24V supply from X4 to power the thermal switch. The separate 24 V DC supply used for the thermal switch can also be used to power the relay in the brake circuit.

Note: There must be reinforced isolation between voltage windings and the temperature sensor as required by IEC 60204-1 and referenced standards.

6.11 Motor Thermal Sensor

Some motors provide a thermal sensor to give feedback of motor temperature. This model of drive does not feature a dedicated analogue input for this function. If using an external CNC, the motor thermal sensors can be connected to one of the drive analogue inputs by means of a voltage divider or two voltage dividers as indicated in the diagrams and have the monitoring implemented in the CNC. The user is then responsible for converting the non-linear voltage output from the circuit into an equivalent temperature for the temperature sensor selected. Two temperature sensors are recommended as in *Figure 6-22 Example Connection of Two Thermal Sensors* in a bridge configuration instead of one sensor. The reasons for this is increased noise immunity because there is twice as much voltage per degree of temperature change, and also because the voltage feeding the divider does not affect the measurement. If this configuration is used the temperature sensors must be co-located; that is they must be in approximately the same physical location.

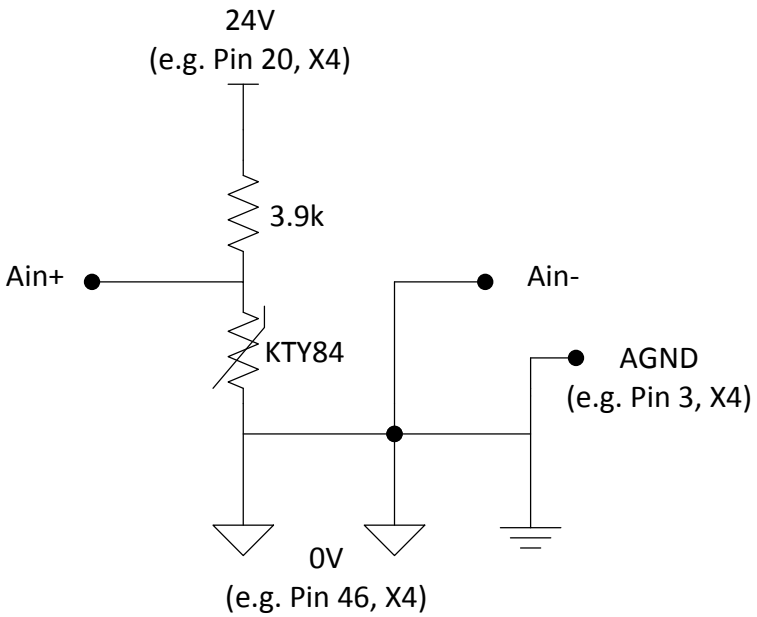


Figure 6-21 Example Connection of Single Motor Thermal Sensor

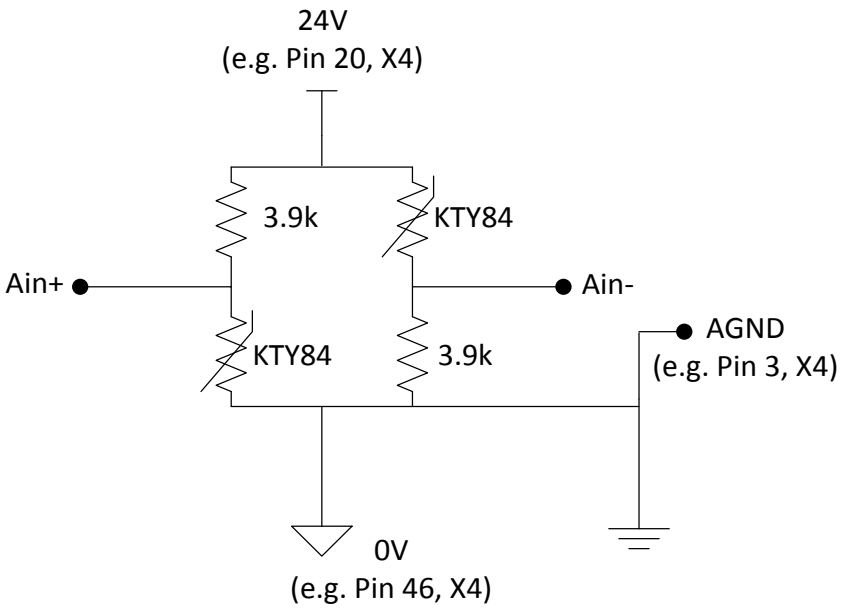


Figure 6-22 Example Connection of Two Thermal Sensors

Note: that there must be reinforced isolation between voltage windings and the temperature sensor as required by IEC 60204-1 and referenced standards.

6.12 Motor Thermal Estimation

An alternative to a Motor Thermal Switch or Motor Thermal Sensor is Motor Thermal Estimation. This is a software feature within the drive which measures the motor current draw and estimates the build-up of residual heat in the motor. Based on this estimate of the motor heat errors can be triggered if the estimate passes a defined threshold. Please see the applicable *AMD2000 Series Servo Drive – CoE Configuration Guide* or *AMD2000 Series Servo Drive – SoE Configuration Guide* for details regarding the configuration of Motor Thermal Estimation.

6.13 Brake/Regeneration Resistor

The D21xx drives feature an inbuilt regeneration resistor. Regeneration refers to the process whereby when the motor is actively providing energy to the drive and then stops, the kinetic energy in the entire mechanical system connected to the shaft of the motor gets transferred to the bus capacitance in the drive, which increases the voltage. This happens because of the motor inductance. When the voltage on the bus capacitance exceeds 385V the drive will connect the internal regeneration resistor in addition to any external regeneration resistor that is provided by the user.

Mode	Connection
Internal Regeneration Resistor	Link pins P & D
External Regeneration Resistor	Connect resistor to P & C

Danger: Do not short circuit connector P to C. Connector P is live with active high voltage.

Please refer to sections *10.4.5 Regenerative Braking* and *10.9 Regeneration Resistor* for additional information.

6.14 DC Busbar Terminals

Danger – High Voltage Area: If you require to access the busbar screw terminals ensure that the drive has been fully discharged. Refer to the Product Rating Sticker on the side of the drive for further information.

The 3A and 9A drives contain 4 x DC busbar screw terminals. These are located under the flip lid as shown. A clear plastic cover is fitted in order to restrict access to these screw terminals. These busbar screw terminals must only be uncovered and accessed when the drive is completely discharged. The clear plastic cover is required to be fitted as shown unless otherwise stated.

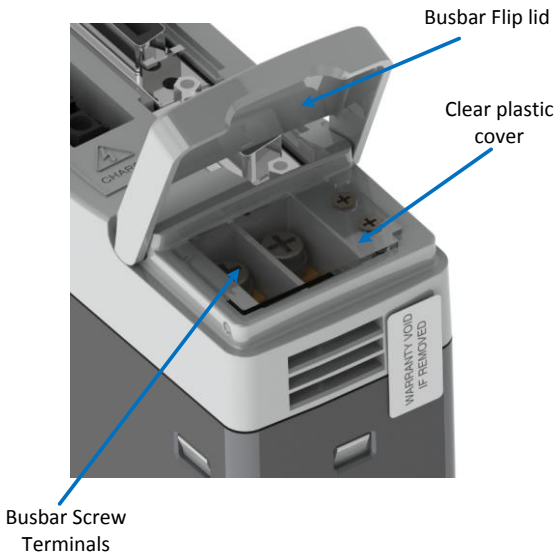


Figure 6-23 D2103 DC busbar screw terminal arrangement

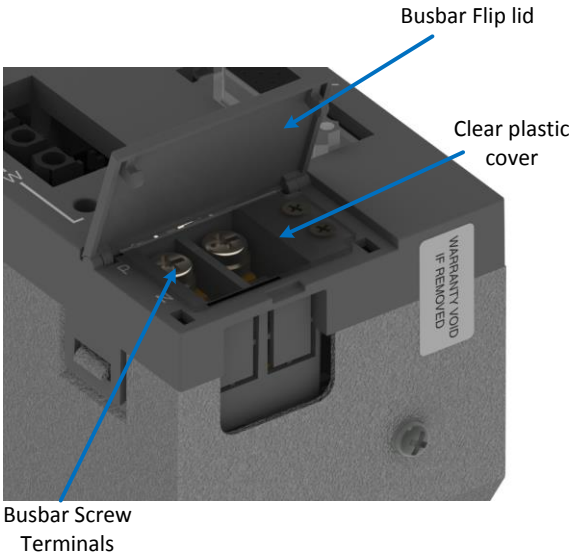


Figure 6-24 D2109 DC busbar screw terminal arrangement

7 Control Wiring

DANGER: The working DC bus is live at all times when power is on. The Main Isolator feeding the drive must be switched to the **off** position at least 15 minutes before any work is commenced on the unit. The operator must check the bus voltage with a tested working voltage measuring instrument prior to disconnecting any connectors or opening the DC Bus terminal cover. The red LED indicator on the front of the drive which indicates that there is charge remaining in the drive is only to be used as an aid to visual troubleshooting. It shall not be relied on as a means of safety.

Warning: Do not plug or unplug connectors while power is applied. It is recommended that the drive is installed with an upstream circuit breaker that is rated appropriately depending on the model of AMD2000 drive being installed.

Turn the Main Disconnect mains isolator switch to the Off position.

Following the appropriate lockout procedure, place a sign over the isolation switch clearly indicating to other personnel that this isolator is not to be touched.

All secondary side control wiring (connectors X1, X2, X3, X4 and X5) and control devices must maintain reinforced isolation to harmful primary side voltages in order that the reinforced isolation characteristics of the drive are not compromised.

7.1 What this Chapter Contains

This chapter contains information related to interfacing of the drives to the following connections:

- Analogue and Digital I/O
- STO
- EtherCAT
- Motor Feedback

7.2 Analogue I/O

All analogue Input and Output signals are connected to the drive via X4 with the following pins,

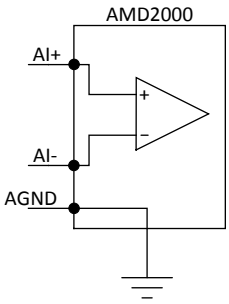
Connector	Pin Number	Label
X4 or I/O Module	1	AI-01+
	26	AI-01-
	2	AI-02+
	27	AI-02-
	28	AO-01
	29	AO-02
	3, 4, 30, 31	AGND

Please refer to section *10.3 Interface Specifications* for detailed specifications

7.2.1 Analogue Inputs

The analogue inputs pass through a differential buffer and second order low-pass filter with a cut-off frequency of approximately 700 Hz.

7.2.1.1 Idealised drawing of Analogue Input Circuit



7.2.1.2 Typical Connection Examples of Analogue Input

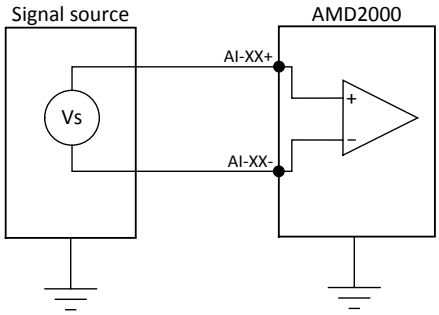


Figure 7-1 Typical Example of Ground Referenced Differential Input Connection

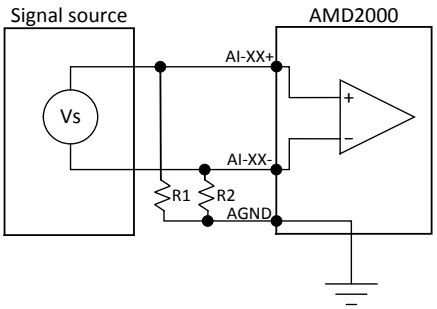


Figure 7-2 Typical Example of Floating Differential Input Connection

Note: R1 and R2 (10KΩ<R1=R2<100KΩ) are bias resistors to keep input common-mode voltage level within the common-mode voltage range of AMD2000 analogue input circuit.

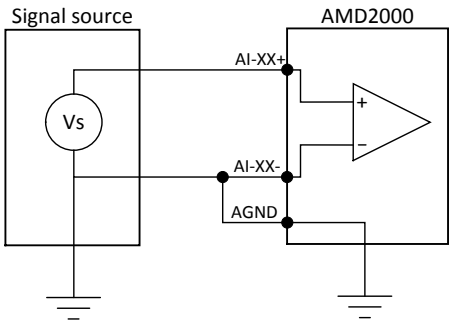


Figure 7-3 Typical Example of Ground Referenced Single-Ended Connection

Note: In the scenario presented in Figure 7-3, any potential difference (in many cases this is 50/60Hz powerline noise) between signal source ground and measurement system ground will be picked up into the measurement result.

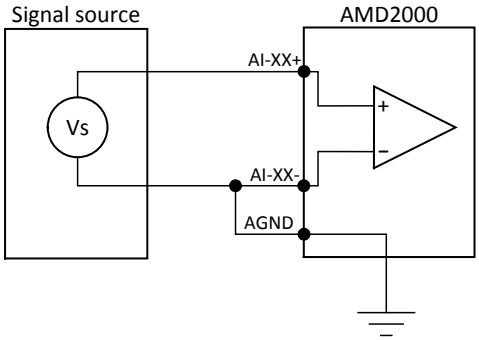


Figure 7-4 Typical Example of Floating Single-Ended Connection

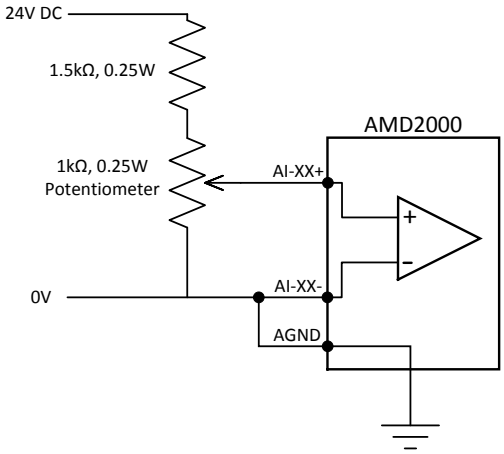


Figure 7-5 Typical Input Circuit to Provide 0-10V Input from a 24V Source

Refer to the applicable *AMD2000 Series Servo Drive - Configuration Guide* for detailed information on how to use ANCA MotionBench to read analogue input values.

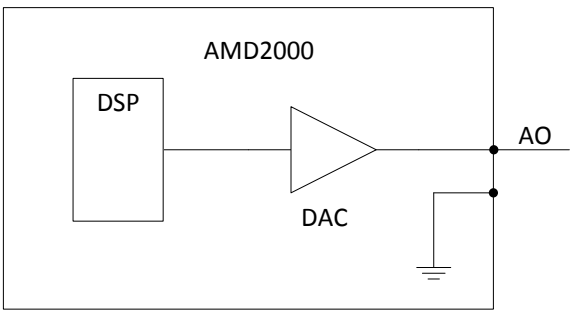
7.2.2 Analogue Outputs

The analogue outputs can be used to output configurable analogue values from the drive.

It is recommended that shielded twisted pair cable is used for interfacing. The shield connection should be made at one end only.

Refer to the applicable *AMD2000 Series Servo Drive - Configuration Guide* for detailed information on how to use ANCA MotionBench to read analogue output values.

7.2.2.1 Idealized Drawing of Output Circuit



7.3 Digital I/O

All digital Input and Output signals are available via connector X4. The AMD2000 provides:

- 8 x General Purpose Inputs
- 2 x additional General Purpose Inputs can be configured if required
- 6 x General Purpose Outputs

Please find details specifications in section *10.3 Interface Specifications*

Connector	Pin Number	Label
X4 or I/O Module (ICN-3077-1150)	7	DI-01
	8	DI-02
	9	DI-03
	10	DI-04
	11	DI-05
	12	DI-06
	13	DI-07
	14	DI-08
	15	DI-09+
	16	DI-09-
	17	DI-10+
	18	DI-10-
	19	DO-01
	22	DO-02
	23	DO-03
	24	DO-04
	25	DO-05
	34	DO-06
	20, 21	+24V-Fused[1]
	46, 47	+24V-GND

[1] Refer to the AMD2000 *Technical Data* for maximum current rating.

7.3.1 24V Control Circuit Supply

The maximum current that can be drawn from this supply is 500 mA total. Note that if a motor with a brake is required this may be insufficient current to release the brake, so an external power supply will be required. Any external power supply must be of the Separated Extra Low Voltage (SELV) type, and approved to IEC 60950. This 24V control supply is primarily electronically protected with the addition of a self-resetting semi-conductor fuse. The effects of exceeding the 500 mA limit depend on the magnitude of the overload.

The reference ground for this 24V control supply is +24V-GND (X4 pins 46 & 47). This reference ground must be connected to the chassis ground (gear tray), in order to establish a “control ground” for the installation.

7.3.2 Digital Inputs

Digital Input Overview

- DI-01 – DI08 are electrically isolated through opto-couplers.
- DI-09 – DI10 are not isolated.
- Reference ground is +24V-GND (X4 pins 46 & 47)

Refer to the applicable *AMD2000 Series Servo Drive - Configuration Guide* for detailed information on how to use ANCA MotionBench to read digital input values.

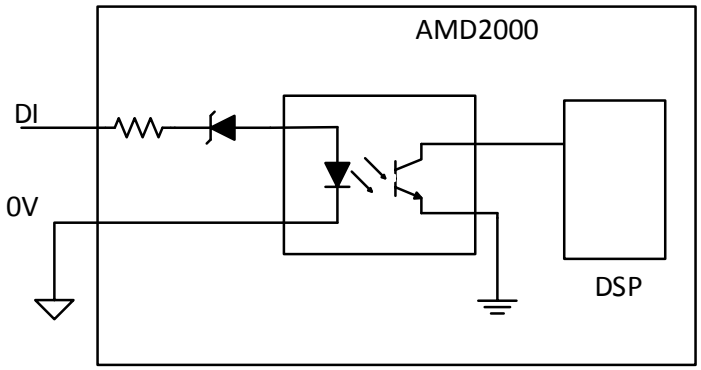
Application examples for the digital inputs include:

- Positive Limit switch
- Negative Limit switch
- Motor over-temperature
- Home switch

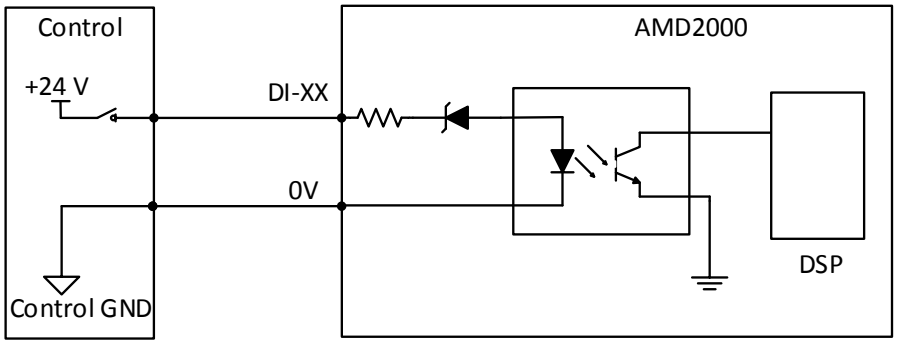
7.3.2.1 General Purpose Digital Inputs DI-01 to DI-08

Warning: Please refer to section *10.3 Interface Specifications* for detailed current ratings of the 24V supply if used to switch I/O devices

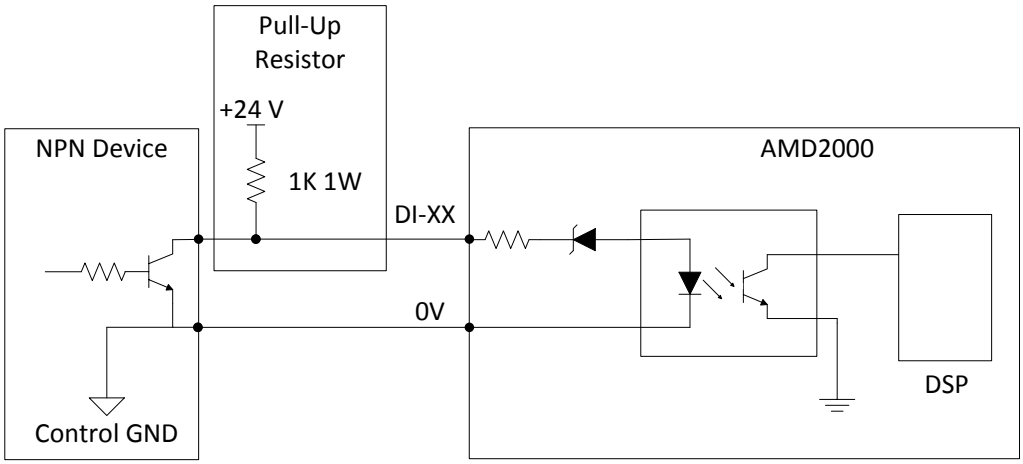
7.3.2.1.1 Idealised Drawing of Input Circuit



7.3.2.1.2 Typical Connection Example



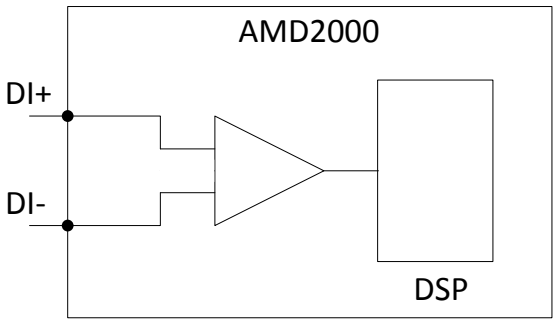
7.3.2.1.3 Typical Connection Example NPN



7.3.2.2 Differential Inputs DI-09 & DI-10

Section *10.3 Interface Specifications* provides detailed information on these two differential inputs. If 2 additional digital inputs are required this may be done safely via optional I/O interface Module accessory listed in 11.4.2 I/O Interface.

7.3.2.2.1 Idealized Drawing of Differential Input Circuit



7.3.2.2.2 Typical Connection Examples of interfacing with PNP/NPN based sensors.

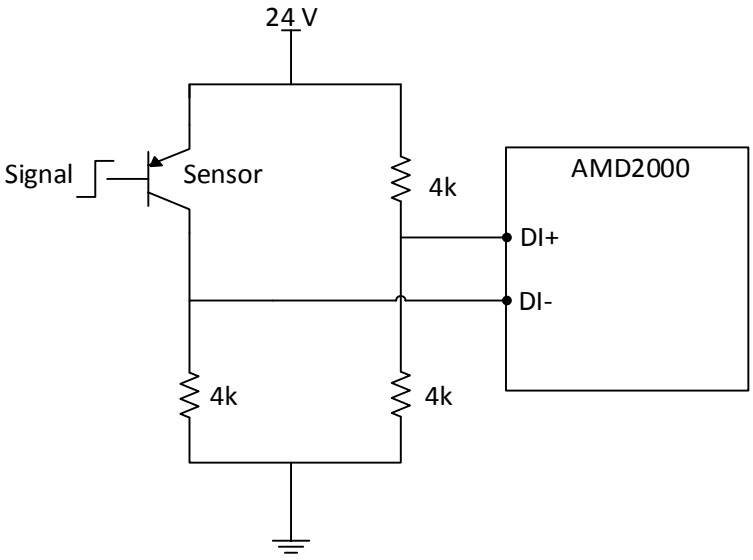


Figure 7-6 - Example PNP Based Sensor

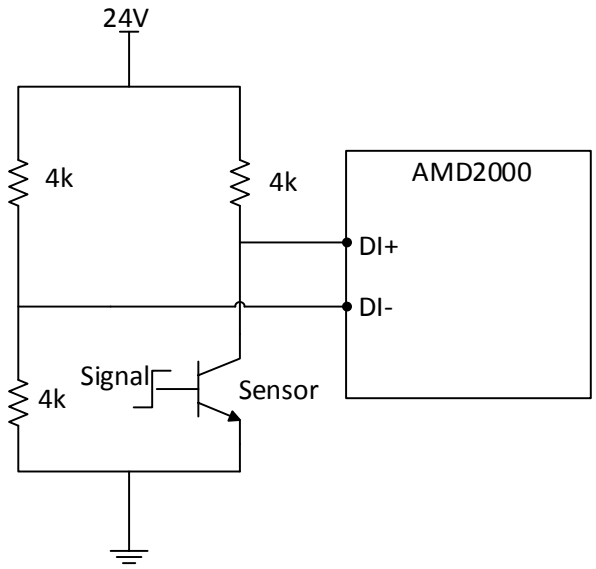


Figure 7-7 – Example NPN Based Sensor

7.3.2.2.3 Connecting 24V single-ended signals using optional I/O module (646-0-05-0723).

See table below for operations of the single-ended inputs when using the 646-0-05-0723 module.

Attribute	Qualification
Nominal Operating Voltage	24 V
Maximum Voltage	30 V
Maximum Input Low Threshold Voltage	5 V
Minimum Input High Threshold Voltage	11 V
Nominal Input Current at 24V Input	15 mA

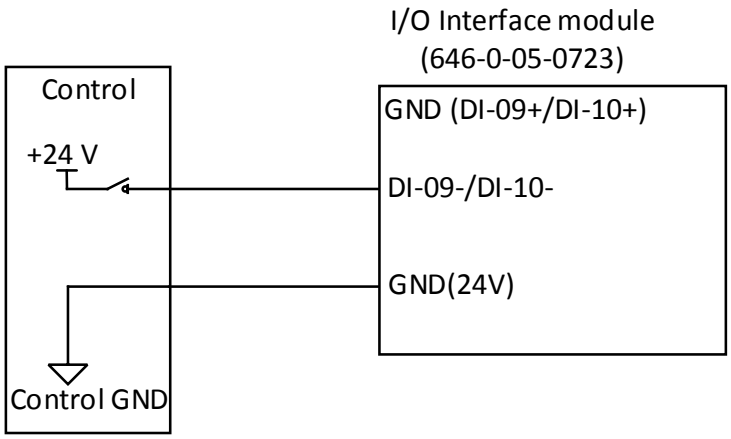


Figure 7-8 – Interface with 24V single-ended signals

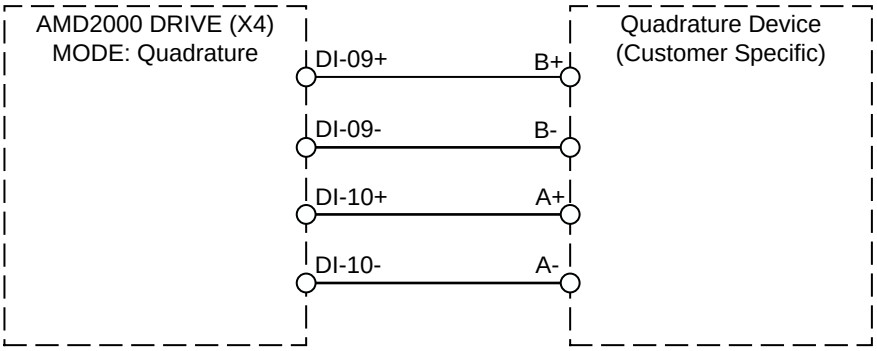
The digital Input and Output signals available via I/O Module (646-0-05-0723) connected to X4 are as follows:

Connector	Pin Number	Label	Function
I/O Module (646-0-05-0723)	7	DI-01	Digital Input
	8	DI-02	Digital Input
	9	DI-03	Digital Input
	10	DI-04	Digital Input
	11	DI-05	Digital Input
	12	DI-06	Digital Input
	13	DI-07	Digital Input
	14	DI-08	Digital Input
	15	DI-09+	Internal Ground (not requiring a GND connection)
	16	DI-09-	single-ended Input
	17	DI-010+	Internal Ground (not requiring a GND connection)
	18	DI-10-	single-ended Input
	19	DO-01	Digital Output
	22	DO-02	Digital Output
	23	DO-03	Digital Output
	24	DO-04	Digital Output
	25	DO-05	Digital Output
	34	DO-06	Digital Output
	20, 21	+24V-Fused[2]	+24V (requiring a GND connection)
	46, 47	+24V-GND	GND (requiring a GND connection)
	48-50	Not Connected	
	51	GND	Internal Ground (not requiring a GND connection)
	52	GND	Internal Ground (not requiring a GND connection)

Please find details specifications in section *10.3 Interface Specifications*

[2] Refer to the AMD2000 *Technical Data* for maximum current rating.

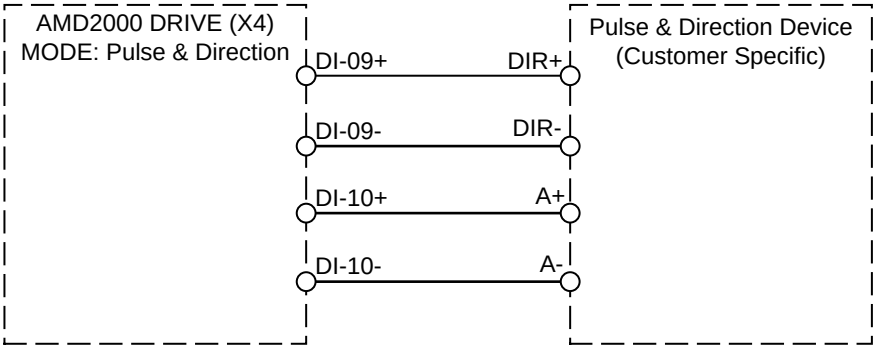
7.3.2.2.4 Connecting a Differential Quadrature Pulse Position Input Device



The drive does not provide power to the quadrature device so the power supply must be provided by the user.
Ensure the ground is common to the ground of the drive so the power supply and signals have a common ground.

Figure 7-9 - Differential Quadrature Mode Wiring Diagram

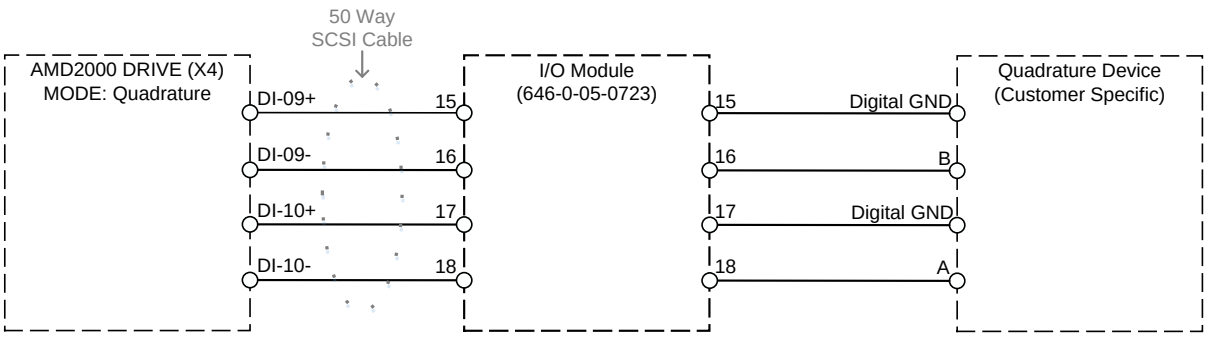
7.3.2.2.5 Connecting a Differential Pulse and Direction Position Input device



The drive does not provide power to the quadrature device so the power supply must be provided by the user.
Ensure the ground is common to the ground of the drive so the power supply and signals have a common ground.

Figure 7-10 - Differential Pulse and Direction Mode Wiring Diagram

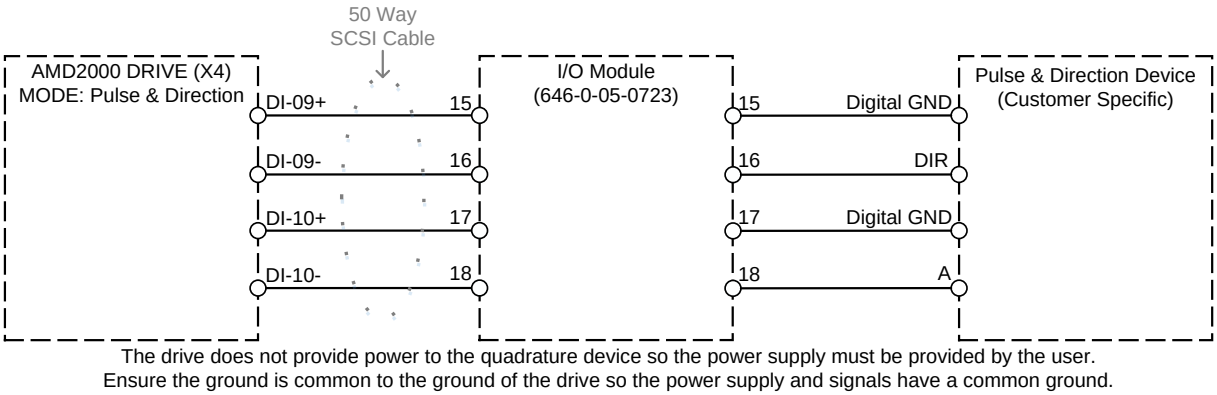
7.3.2.2.6 Connecting a Single Ended Quadrature Pulse Position Input device



The drive does not provide power to the quadrature device so the power supply must be provided by the user.
Ensure the ground is common to the ground of the drive so the power supply and signals have a common ground.

Figure 7-11 - Single Ended Quadrature Mode Wiring Diagram

7.3.2.2.7 Connecting a Single Ended Pulse and Direction Position Input device.



The drive does not provide power to the quadrature device so the power supply must be provided by the user.
Ensure the ground is common to the ground of the drive so the power supply and signals have a common ground.

Figure 7-12 - Single Ended Pulse and Direction Mode Wiring Diagram

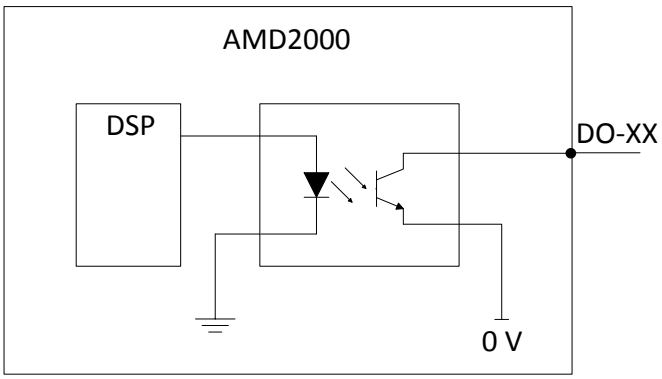
7.3.3 Digital Outputs

The digital outputs can be used to output pre-programmed functions stored in the drive e.g. relay control.

Digital Output Overview

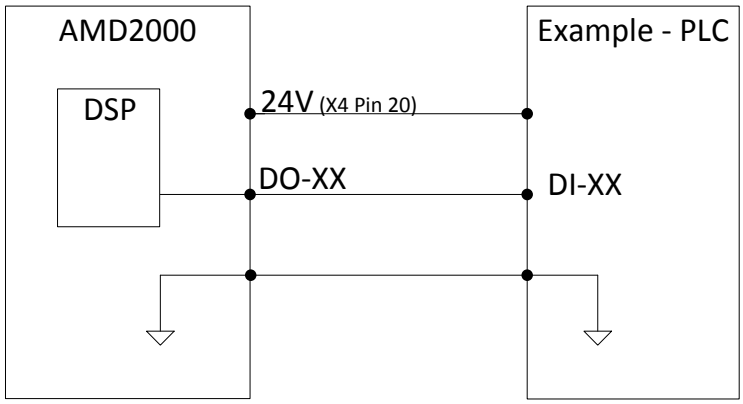
- Outputs are current sinking
- Refer to Section *10.3 Interface Specifications* for maximum current ratings
- All Digital outputs are pulled to ground

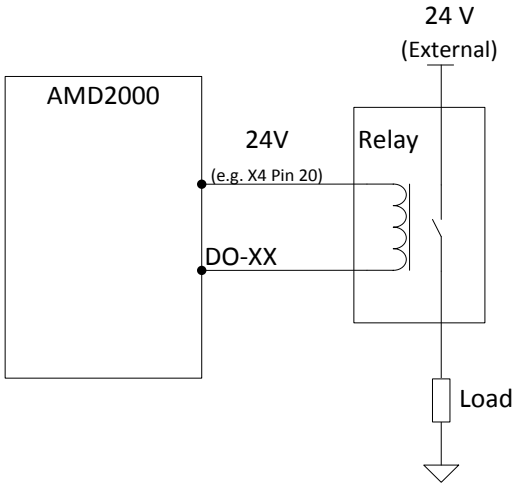
7.3.3.1 Idealized Drawing of Digital Output Circuit

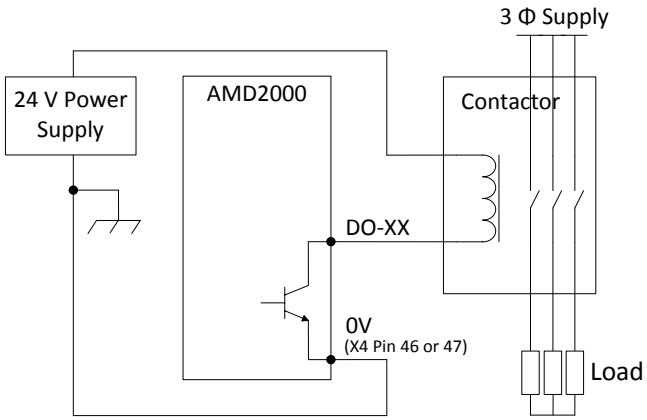


Refer to the applicable *AMD2000 Series Servo Drive - Configuration Guide* for detailed information on how to use ANCA MotionBench to read digital output values.

7.3.3.2 Typical Connection Examples







7.4 Safe Torque Off (STO) Operation

7.4.1 Definitions

STO	The Safe Torque Off function.
Safe State	The drive can no longer supply power/torque to its motor.
Active or Activated	The STO has been triggered and the drive will either be attempting to reach its Safe State, or has reached its Safe State, where it is unable to deliver power or torque to its associated motor. The STO function may be triggered via an external demand (see Demand below), or as an internal consequence of its own fault detection mechanisms.
Demanded, Requested or Asserted	STO has been requested to Activate as a result of detecting a de-powering of the STO inputs.
Standby	STO has not been activated.
SFR-A/SFR-B	STO Fault Relay output A/STO Fault Relay output B.

7.4.2 STO Overview

7.4.2.1 Introduction

The AMD2000 servo drive (model D21xx) has a Safe Torque Off function that interrupts torque producing power being provided to a motor. STO provides a SIL Claim Level 3 safety function according to IEC 61800-5-2:2007, or an equivalent performance level of PL=e, Category 4, according to ISO 13849-1:2006.

Warning: In order to claim these levels of safety performance in an installation, it is the machine builder's, or integrator's, responsibility to use suitably qualified and experienced personnel to design, commission and operate safety systems for the application of interest. STO in the drive itself is not the sole basis for claiming SIL or PL when installed on a machine.[3]

STO can be used to prevent unexpected start-up of the motor without having to shut the drive down or remove input power. STO works by disabling the internal PWM signals so that the power module connected to the motor cannot be turned on.

Warning: STO will not brake the motor (STO performs a function similar to Stop category 0, IEC 60204-1) so, if moving, the motor will only coast to a stop when STO is activated.

STO is implemented with two separate inputs that must be powered for the drive to be able to operate. In this condition STO is considered to be operating in standby. STO has detected no faults (internal or external), and has received no demand to activate. An AMD2000 I/O interface module is required to setup STO and power must be applied to the STO connections of this I/O module. This power can be provided by either the internal 24V power supply of the AMD2000 drive or from an external power supply (See notes on the bottom of section *7.4.5.1* about requirements and approvals on an external power supply).

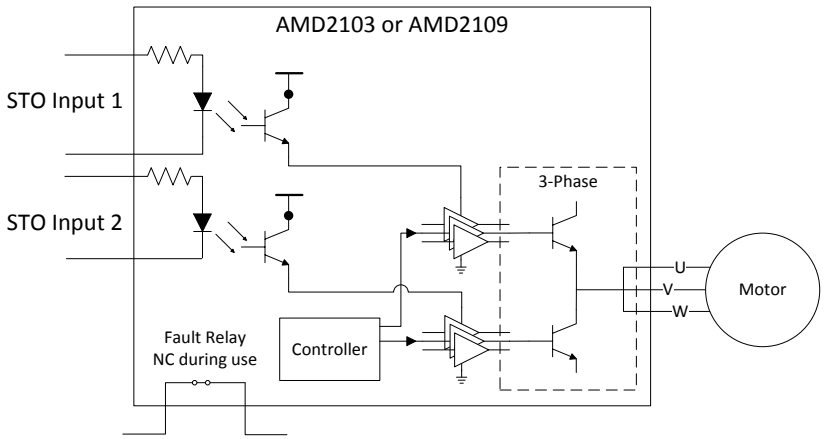


Figure 7-13 STO Implementation

Warning: STO does not remove AC power from the drive itself. If maintenance or repair work is to be carried out on the machine, the drive should be isolated from all power supplies first. Please read the User Guide for isolation requirements and techniques. You must also wait for **15 minutes** after power removal for internally stored energy to discharge.

Warning: It is not recommended to stop the drive using the STO function as this is an uncontrolled stop. The motor will only coast to a stop and depending on the application this may result in unacceptable behaviour.

[3] Guidance regarding staff levels of training and competence are given in IEC 61508.

Warning: When using a three phase permanent magnet synchronous motor and in the case of multiple gate failure, the motor may unexpectedly rotate up to 180 electrical degrees (180/p mechanical degrees where p is the number of poles).

7.4.3 STO Considerations

- Suitably qualified, trained and authorised personnel must configure and commission STO for use on a machine.
- A hazard analysis must be carried out to evaluate safety risks and to design a suitable safety system in which STO may be integrated.
- This drive must be installed in a suitable location under suitable ambient conditions (see section *10.5 Environmental Specifications*).
- Acceptance tests must be performed to verify the correct operation of the safety system and STO function of this drive. The acceptance test procedure (see section *7.4.8 STO Function Commissioning Test Procedure*) should be carried out after any of the following occur:
    - On initial installation and commissioning of the safety function.
    - After making any changes to the system including wiring, components or settings.
    - Any time a STO Override Plug (*11.4.5 STO Override Plug*) is removed from the X4 interface for the purpose of returning STO to operation.
    - After any maintenance of the machine or machine safety system.
- The STO feature contains no user maintainable components, and will therefore not require any user maintenance. No opening of the drive for maintenance should be attempted, and any such attempt will result in the STO feature no longer being considered as providing a safe function. Anti-tamper stickers are clearly shown on the drive to discourage such maintenance. Replacement of the fan assembly on the D2109 is specifically exempt and is the only maintenance allowed on the Drive.
- This STO feature is designed for uncontrolled stops (similar to Stop category 0, IEC 60204-1); only removing torque from the motor. The speed at which the motor and load moves after activation may depend on many factors.

7.4.4 STO Operation

The drive contains two separate STO inputs that **must** both be used. When both inputs are powered and no fault has been detected, STO is in a standby state and the drive will operate normally. *Table 7.4.2.1-1 - STO Input Ratings* describes the STO input requirements.

STO input	Nominal	Maximum	Units
Input Voltage	24 (+/-20%)	30	VDC
Input current		10	mA

Table 7.4.2.1-1 - STO Input Ratings

Warning: If either STO input is energised above approximately 30 V damage may occur to the drive.

STO is activated (i.e. asserted) when power is removed from either STO input for a duration longer than 1ms. Correct operation requires both inputs to be asserted simultaneously for a similar duration. The AMD2000 allows for both inputs to assert or de-assert within 120 ms of each other for this purpose. A duration separating a change in demand to each input of longer than 120 ms may result in a fault condition. In either situation, the drive will achieve its Safe State and no energy will be supplied to the motor.

Whenever the STO inputs are asserted, the blocking of energy supply to the motor is a SILCL 3 certified safety function and will occur within 50 ms of the assertion.

Whenever the STO function indicates a fault through either of its fault relays, the blocking of energy supply to the motor is a SILCL 3 certified safety function and will occur within 50 ms of detecting a fault (faults are described in detail in *7.4.6 Fault detection*).

Depending on the operating mode of the drive, STO assertion (without faults) can result in two different outcomes;

1. If the drive was in an 'enabled' state when STO was asserted, an error will be registered by the drive along with STO blocking power delivery to the motor. There are two different sequences that may be employed to reset from STO in this situation;[4]
   a. The **recommended** sequence is to first disable the drive, then clear the drive error, and subsequently de-assert (24V) the STO inputs, but
   b. It is also possible to reset to normal operation by de-asserting (24V) the STO inputs, and then clearing the drive error while the drive remains enabled.

   In either approach it is the responsibility of the machine integrator or installer to appropriately assess the hazards, given the understanding that de-asserting STO removes the drive's safety system block on power being delivered to the motor.

2. If the drive was NOT 'enabled' when STO was asserted, then the safety function will simply remove power from the motor. The drive may be reset to normal operation by simultaneously de-asserting (24V) both STO inputs. De-asserting STO inputs while not enabled, results in immediately allowing power to be delivered to the motor and the drive will not display any errors in normal operation (ie. no faults).

Warning: STO performs a reliable removal of energy supply to the motor ONLY when both STO inputs are asserted. It is the responsibility of the machine builder or integrator to determine whether additional safety systems are required to maintain power removal from the motor if STO is de-asserted while the drive is 'enabled.' Care should be exercised, as the drive does not reliably and safely block power delivery to the motor when STO inputs are **de-asserted**, unless a fault has occurred in the STO system.

Warning: It is the responsibility of the machine builder or integrator to determine whether additional safety systems are required to maintain power removal from the motor if STO is to be de-asserted while the drive is NOT 'enabled.'

If a fault in STO does result, from either too long a duration between STO input assertions matching, or some other fault detection reaction internal to the drive, then the drive must be restarted (turn off for more than 2 seconds, then turn on[5]) in order to recover to under normal operating conditions (ie. no faults[6]). If the motor and load associated with the drive was moving at the time when STO was demanded, it may only coast to a stop. In this state the motor will not be able to be driven, nor resist external forces/torques, regardless of what the drive commands.

Application of motor torque becomes possible when both STO inputs are re-powered, and all fault/error conditions are cleared. This will allow the drive to operate normally and any commanded drive activity will have to be set running again.

Warning: Applying a sequence of shorter than 1ms assertions can still result in STO if the durations of de-assertion (24V) between each assertion are shorter than 10 ms.

Note: Both STO inputs must change within the 120ms timing window, whether asserting or de-asserting STO or the drive may trigger a fault reaction as described in *7.4.6 Fault detection*.

Note: Some safety programmable logic controllers (PLCs) have test pulse features. The AMD2000 (D2103 or D2109) is designed so that it will not respond to STO assertions (0V) on the inputs of 1ms or less in duration, as long as the intervening periods of de-assertion at least 10ms or longer.

[4] Refer to the *AMD2000 Series Servo Drive - Configuration Guide* for instructions on how to clear drive errors, or disable and re-enable the drive.
[5] If the drive is not turned off for a long enough duration, it is possible the fault will not be cleared, and the drive will remain in the safe state.
[6] If an internal fault is re-detected on start-up, or if the inputs asserting STO continue to not match, then STO will re-enter a fault state upon start-up and will continue to be unable to deliver power to a motor.

7.4.5 STO Wiring

Warning: Wiring of the AMD2000 for STO must be designed and commissioned by suitably qualified personnel.

STO uses an isolated dual channel implementation so that the function is fault tolerant, however both channels need to be asserted or de-asserted within 120ms for the drive to **not** detect a fault. IO pins and nominal voltages for each are given in the following table. It is not necessary to use the drive's internal power supply to power the STO inputs, but any external power supply must be suitably PELV and must be appreciated for its impact on the safety function by qualified personnel, such as by approval to IEC 60950.

Name	AMD2000 I/O interface module	Nominal voltage
+STO 1	45	+24VDC
-STO 1	43	0VDC
+STO 2	49	+24VDC
-STO 2	50	0VDC
SFR-A	5	+24VDC
SFR-B	6	+24VDC
+24V	20 & 21	+24VDC (output)
0V	46 & 47	0VDC(output)

Table 7.4.2.1-1 - STO connections

Warning: The STO inputs are electrically isolated from each other, and isolated from the internal +24V power supply. Cable inputs should be suitably wound, suitably separated, shielded and grounded, and may not exceed 15 m in length. Avoid tight bending and installations leading to abrasion in the cable.

If STO is not required for machine safety, then both STO channels can be connected directly to the drive's own 24V power supply as described in section *7.4.5.5 When STO is not required*, or some other suitable 24V power supply. Example wiring diagrams are given elsewhere in this document (see *7.4.5.1 Example Wiring Installation for a Single AMD2000 using STO* and *7.4.5.2 Example Wiring Installation for Multiple AMD2000 using STO*). Any switching contacts on the STO inputs must operate within 120ms of each other; otherwise a fault will be detected as described in section *7.4.6 Fault detection*.

A number of common external failure modes result in safe state via the action of the STO function.

- In the event that a STO input (IO 45,43 and/or IO 49,50) is wired with reverse polarity, the STO circuit will detect a STO assertion on that channel, and the drive will enter the safe state.
- STO input wires that fail to transmit the required threshold voltage (eg. due to corrosion) will be detected as STO assertion on that channel, and the drive will enter the safe state.
- Similarly, cable disconnections or failures to connect will also result in STO assertion.
- If either of the above failure modes occurs on just one channel, then this fault will be registered by the drive by opening its fault relay.

Some external failure modes are difficult to detect via the actions of the STO function alone (for example, crossed wiring of inputs), so information regarding the sensed levels of STO inputs, STO reactions and faults can be examined via ANCA MotionBench software or the drive's EtherCAT fieldbus. MotionBench and EtherCAT STO related signals are described in the *AMD2000 Series Servo Drive – CoE Configuration Guide* or *AMD2000 Series Servo Drive – SoE Configuration Guide.*

7.4.5.1 Example Wiring Installation for a Single AMD2000 using STO

When using single drive in a machine, the STO wiring may be wired as shown in *Figure 7-14 – Single drive STO wiring example* below.

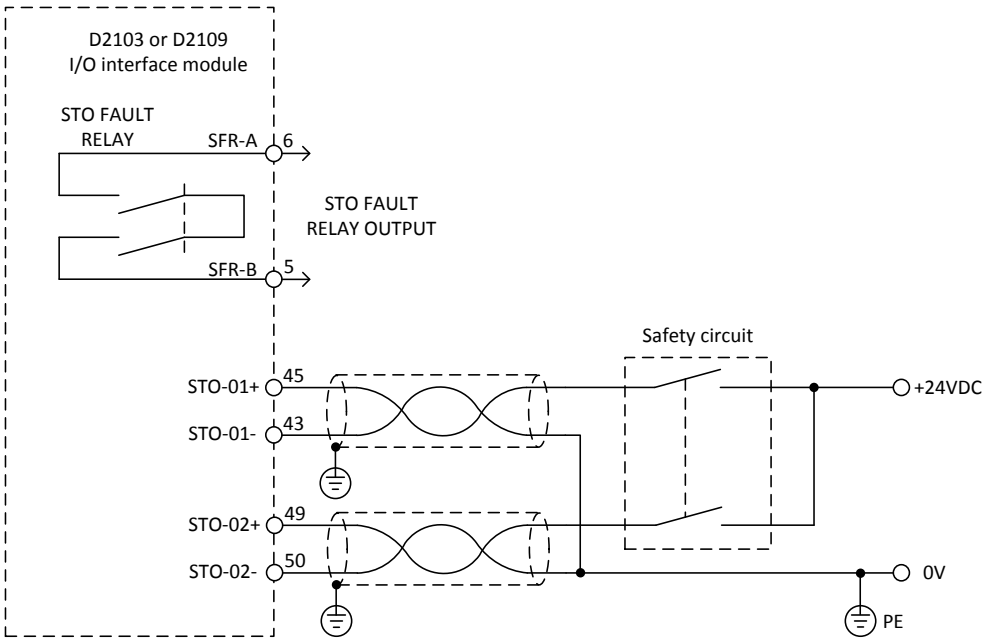


Figure 7-14 – Single drive STO wiring example

Note: The internal +24V power supply has a limited output capability (refer to the AMD2000 User Guide for details). Over current protection inside the drive will cause the +24V output to cease if too much load is connected. If this supply is shared between STO and the six digital outputs, then you must ensure that you stay under the current limit threshold. If the limit is exceeded, it will cause the STO function to activate and therefore, stop the motor. If you are concerned about power supply loading causing false STO trips, then it is recommended that a reliable external power supply is used. Note that any external power supply must be of the Protected Extra Low Voltage (PELV) type and approved to IEC 60950.

7.4.5.2 Example Wiring Installation for Multiple AMD2000 using STO

When using multiple drives in a machine, the STO wiring may allow daisy chaining to each of the drives as shown in *Figure 7-15 - Multiple drives STO wiring example*.

Warning: It is the machine builder's responsibility to ensure the correct design and installation of the safety systems on a machine for hazard reduction. Such 'daisy chains' are not always suitable.

In this example the STO channels are powered from an external +24V DC power supply (see notes in *Table 7.4.2.1-1 - STO Input Ratings* about external power supply requirements and approvals). The voltage rating of the external power supply should be compatible with the conditions listed in *Table 7.4.2.1-1 - STO Input Ratings.* Each channel will draw the current listed in *Table 7.4.2.1-1- STO Input Ratings*, so the power supply should be sized accordingly taking into account the number of drives in parallel.

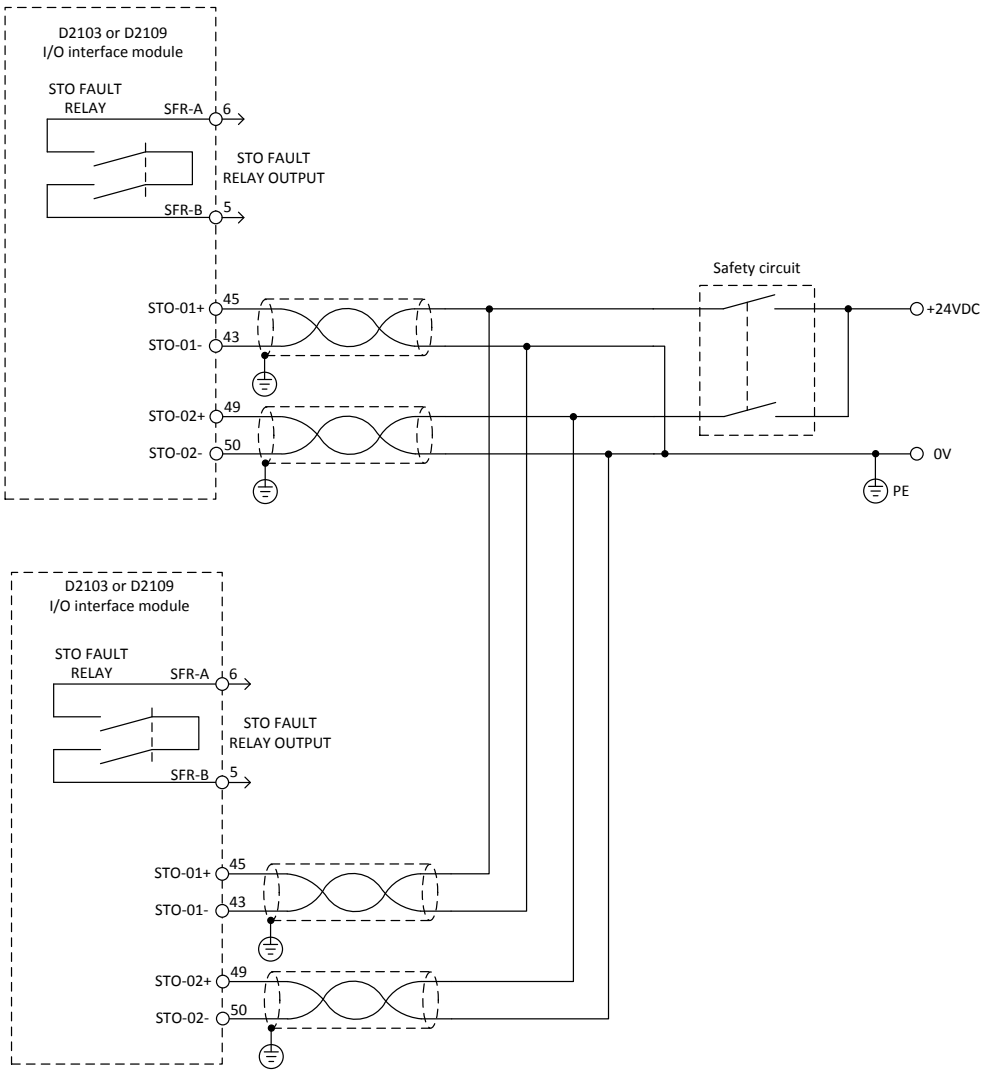


Figure 7-15 - Multiple drives STO wiring example

Note: If you are wiring multiple drives together, 24V power requirements must be carefully considered. If using the AMD2000 internal power supply, be careful not to exceed power supply current limits (refer to the note at the bottom of section *Table 7.4.2.1-1 - STO Input Ratings*). Failure to do so may result in activation of over current protection and may therefore cause unexpected STO activation.

7.4.5.3 Example of Integrating a Single STO drive with a Safety Circuit

The following example uses a Safety Relay Module as an example of a safety circuit to demonstrate integration to a single STO drive

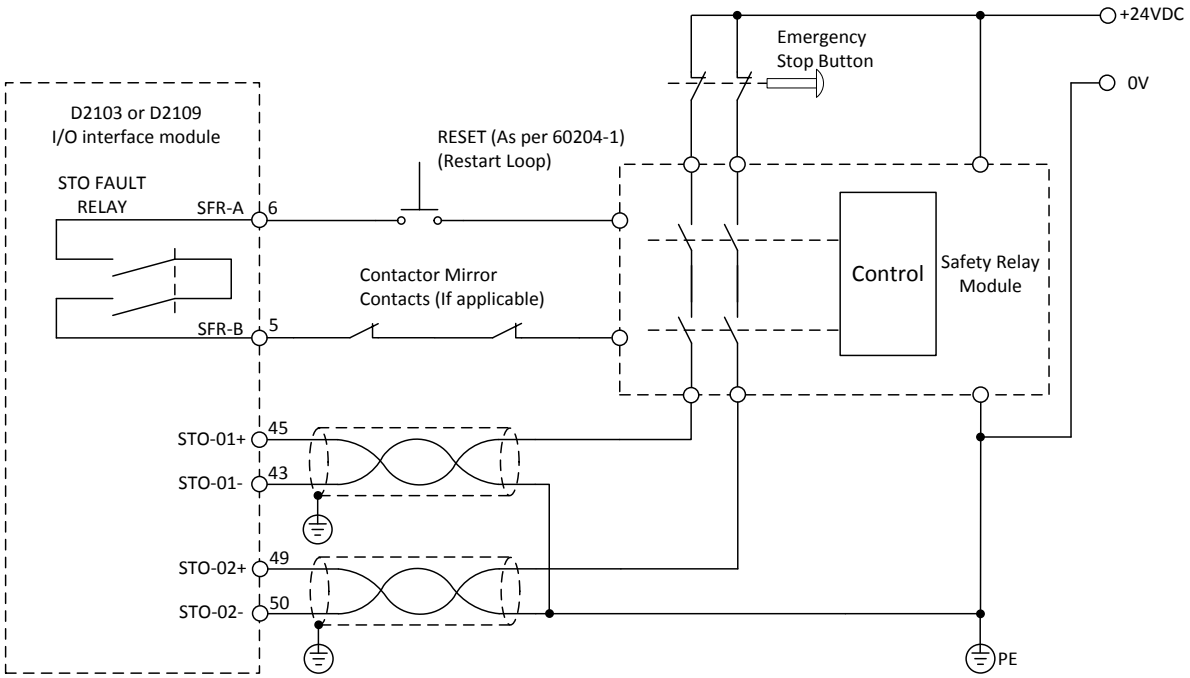


Figure 7-16 Example of Integrating Single STO Drive to Safety Circuit

Note: Requirement for IEC60204-1 regarding earth fault detection must be followed.

Note: Installation of the safety circuit will need to follow particular installation instructions for chosen unit and requirements of IEC 60204-1.

7.4.5.4 Example of Integrating a Two STO drives with a Safety Circuit

The following example uses a Safety Relay Module as an example of a safety circuit to demonstrate integration to two STO drives

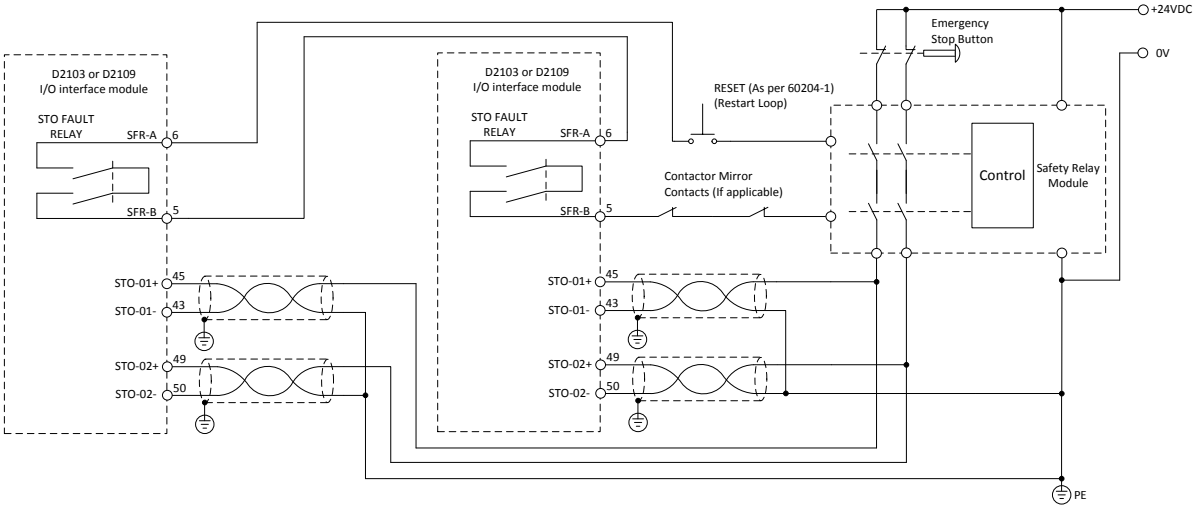


Figure 7-17 Example of Integrating 2 STO drives to Safety Circuit

Note:

1. Requirement for IEC60204-1 regarding earth fault detection must be followed.
2. Installation of the safety circuit will need to follow particular installation instructions for chosen unit and requirements of IEC 60204-1.

If you are wiring multiple drives together, 24V power requirements must be carefully considered. If using the AMD2000 internal power supply, be careful not to exceed power supply current limits (refer to the note at the bottom of section *Table 7.4.2.1-1 - STO Input Ratings*). Failure to do so may result in activation of over current protection and may therefore cause unexpected STO activation.

7.4.5.5 When STO is not required

If STO is not required, loopback wires may need to be installed onto the AMD2000 I/O interface module as shown in *Figure 7-18 - STO feature not used*. Without this wiring the drive cannot operate. Also, refer to the note in section *Table 7.4.2.1-1 - STO Input Ratings* about power supply loading. There is no requirement to use the AMD2000 internal power supply in this instance, but this is displayed here for convenience.

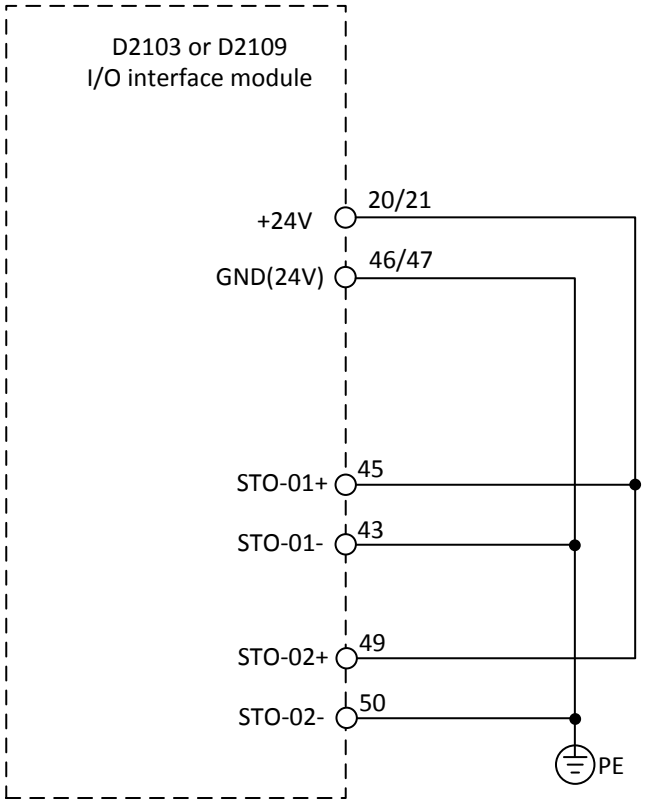


Figure 7-18 - STO feature not used

7.4.6 Fault detection

Any detected fault in STO results in both STO activation, and the opening of the fault relay. The drive must be power cycled (turned off, wait 10 seconds and turn on) before it will be able to recover from a fault. STO incorporates both internal **and** external fault detection.

External detection is provided by examination of the STO inputs. For correct operation of STO, both of the STO inputs must always have the same logic level. If a difference is detected for a long enough duration, then STO is activated and the fault relay is opened. This is intended to prevent bouncing contacts or mechanical differences between the STO activation circuits from tripping false errors. Differences shorter than 120ms will not be detected as a fault. Differences longer than 240ms will be detected as a fault and the fault relay will be opened. Any duration of difference between 120ms and 240ms will result in an uncertain consequence, which may or may not be detected as a fault. Refer to *Figure 7-19 - STO Timing Diagrams* and *Table 7.4.5.5-2 - STO Timing Specifications* for more details.

Internal detection is provided by examination of the power delivered to both high and low side opto-couplers to the gates. Monitoring detects agreement in power supply levels between these two sets of opto-couplers, as well as their independent power levels.

The fault relay is a voltage free relay output accessed via the AMD2000 I/O interface module. Do not exceed 100mA on its contacts. This output is always in the 'closed' position when no fault has been detected. If a fault is tripped, the output switches to the 'open' position. This output is intended only for connection to an external machine safety system or fault indicator. When a fault is indicated, the 'open' condition will remain and the drive will remain in the Safe State no matter what signal is applied to the STO inputs. The only way to reset from a fault and restore drive operation is to power cycle the drive. This is a deliberate mode of operation to ensure that the operator is aware of any faults and cannot un-expectedly restart operation from such a fault condition. *Table 7.4.5.5-1 - STO Fault Relay output ratings* describes the STO Fault Relay output requirements.

STO Fault Relay output (SFR-A/SFR-B)	Nominal	Maximum	Units
Voltage	24 (+/-20%)	30	VDC
Sink/source current		100	mA

Table 7.4.5.5-1 - STO Fault Relay output ratings

Warning: If any input is energised above approximately 30 V damage may occur to the drive.

This fault detection circuitry does not ensure that STO is fault free and it is up to the machine builder and operator to ultimately ensure machine safety. A fault might only be detected when the STO is activated, for example. This might occur in the instance when a contact on one STO input is stuck on. One input will open in response to a demand for STO, while the stuck input will not. This is only detectable upon demand. When STO is not being demanded this fault is no longer detectable by the drive.

Warning: If a STO fault occurs, always test the STO feature before returning the drive back into service**.** Faults in the operation of STO must be identified and logged immediately by the operator of the machine. All faults MUST be reported to ANCA Motion, and no maintenance or repair of a drive is allowed. Faulty drives should be returned to ANCA Motion for further evaluation.

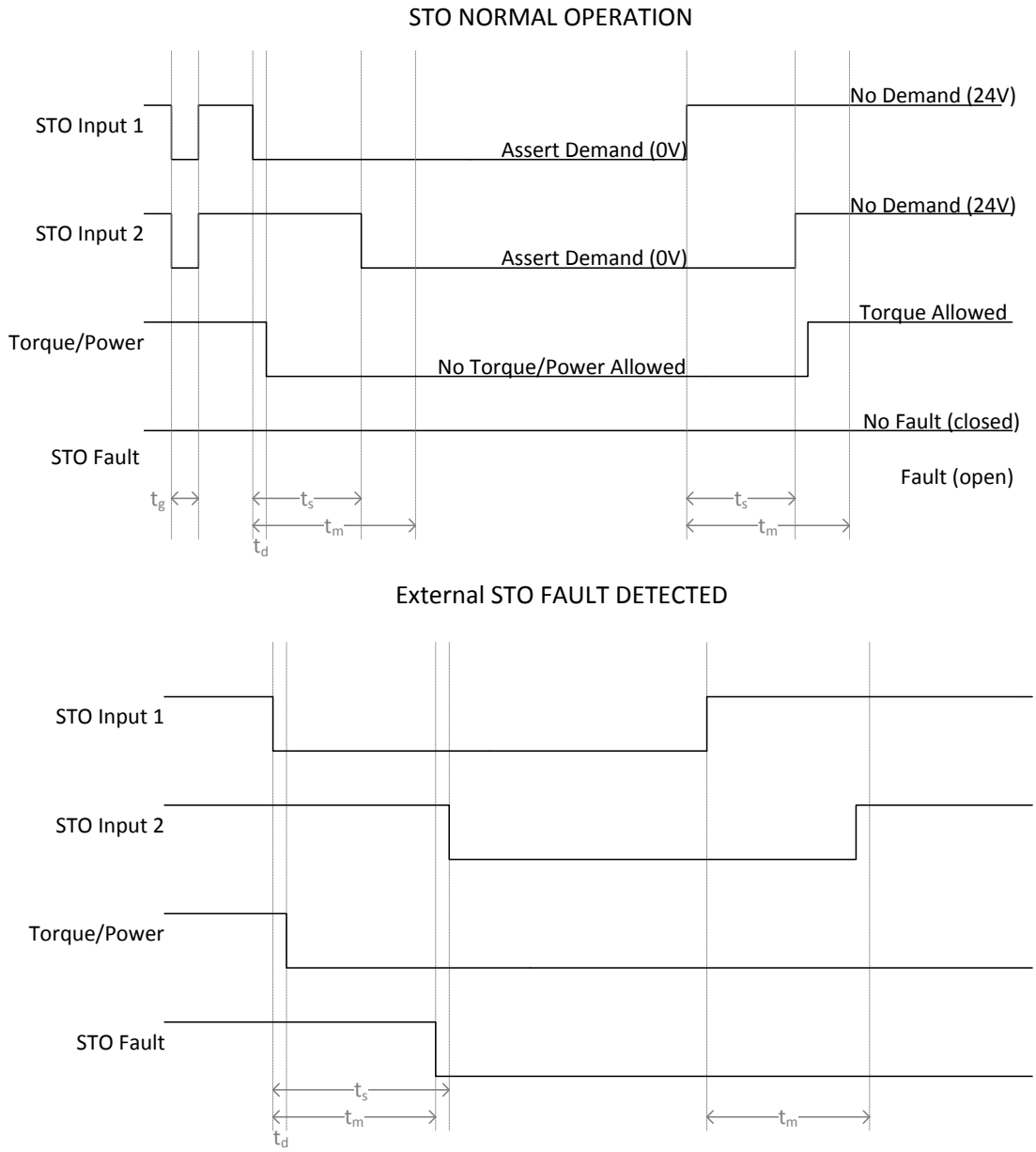


Figure 7-19 - STO Timing Diagrams

Parameters	Description	Values	
		Min (ms)	Max (ms)
t_s	Time between STO input demand asserted or de-asserted	N/A	N/A
t_d	Time between first STO input demand detected and Torque/Power shut down	N/A	50
t_g	Time below which STO demand changes are ignored (from safety PLC pulses, for example)	N/A	1[7]
t_m	Maximum time allowable between differing STO demands before external Fault detected	120	240

Table 7.4.5.5-2 - STO Timing Specifications

[7] t_g assumes at least 10ms between low transitioning pulses

7.4.7 STO Diagnostics

Warning: The STO function of the AMD2000 is entirely hardware based. No software, firmware or diagnostics available through the drive firmware can or should be used in the formulation of safety functions external to the drive. There is no claim made concerning the reliability of the STO diagnostic software.

The drive controller does, however, see the status of the safety system and can display the appropriate error code or status information under no fault conditions.

- If STO is requested while moving a motor, or if the drive is commanded to move a motor while STO is active, an error code will be reported and shown on the drive's LED display. The error code for this condition is E0070. This type of error can be cleared by de-asserting the STO inputs and sending a reset error command to the drive via the EtherCAT interface. Refer to the *AMD2000 Series Servo Drive - Configuration Guide* for details concerning resetting errors.
- If the drive is not enabled (and therefore not able to move a motor) the drive may still be queried via EtherCAT to determine if the STO is asserted, as this is considered a normal operating condition and will not result in an error or fault. Refer to the *AMD2000 Series Servo Drive - Configuration Guide* for details concerning how to access this information.

Alternatively, if STO has entered a fault condition, opening its fault relays (as described in *7.4.6 Fault detection*) then E0071, E0072 or E0073 will be reported on the drive's LED. In this case, the error can only be reset by power cycling the drive. If the cause of the fault persists after power cycling, then the error will not be able to be cleared.

Note: The STO Diagnostics described in the section are NOT certified safety functions.

7.4.8 STO Function Commissioning Test Procedure

The purpose of this test is to ensure that STO is operating correctly.

Ensure there is no risk of injury to persons or property when testing the STO function of this drive, remember that STO will not apply any braking to the motor connected to the drive; only remove torque. For this reason and for general safety, low speeds and loads with as little inertia as possible are suggested to be used.

Disconnect the two STO inputs from the drive. Obtain two single pole double throw (DPST) switches. Wire as per *Figure 7-20 - STO Test Setup* below.

Follow the flow charts described on the following pages in order to evaluate the STO function. There are three sub-tests to be executed. Any single failure in any sub-tests leads to an overall failure.

Warning: Performance during this test should be logged by the operator of the machine, and assessed by suitably qualified personnel for safety related functions. All faults or mis-performance/deviations from this test procedure MUST be reported to ANCA Motion, and no maintenance or repair of a drive is allowed. Please organise with ANCA Motion to return the drive for assessment.

Warning: The following tests use the motor becoming stationary as evidence of motor torque removal. Do not use a part of the body to assess this.

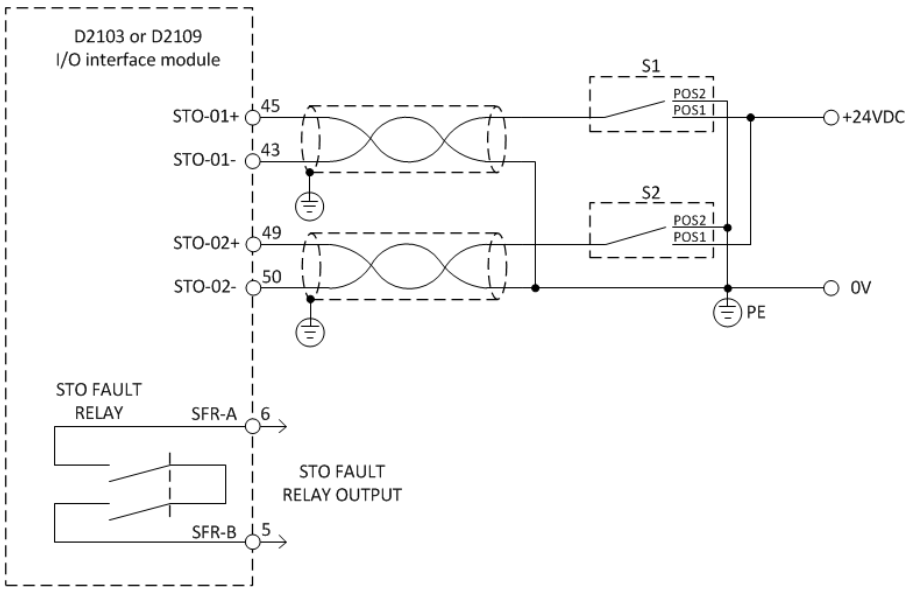


Figure 7-20 - STO Test Setup

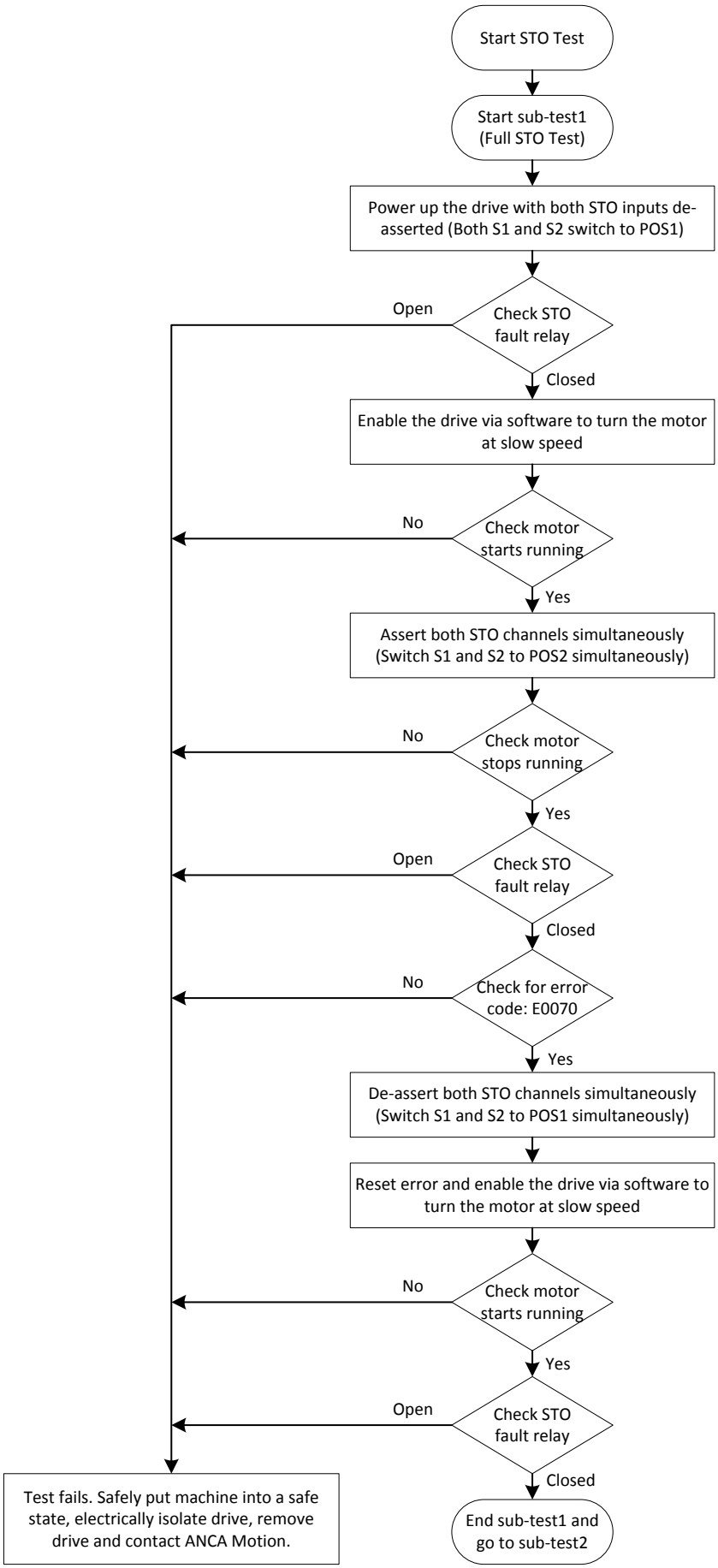


Figure 7-21 - STO Sub-Test 1

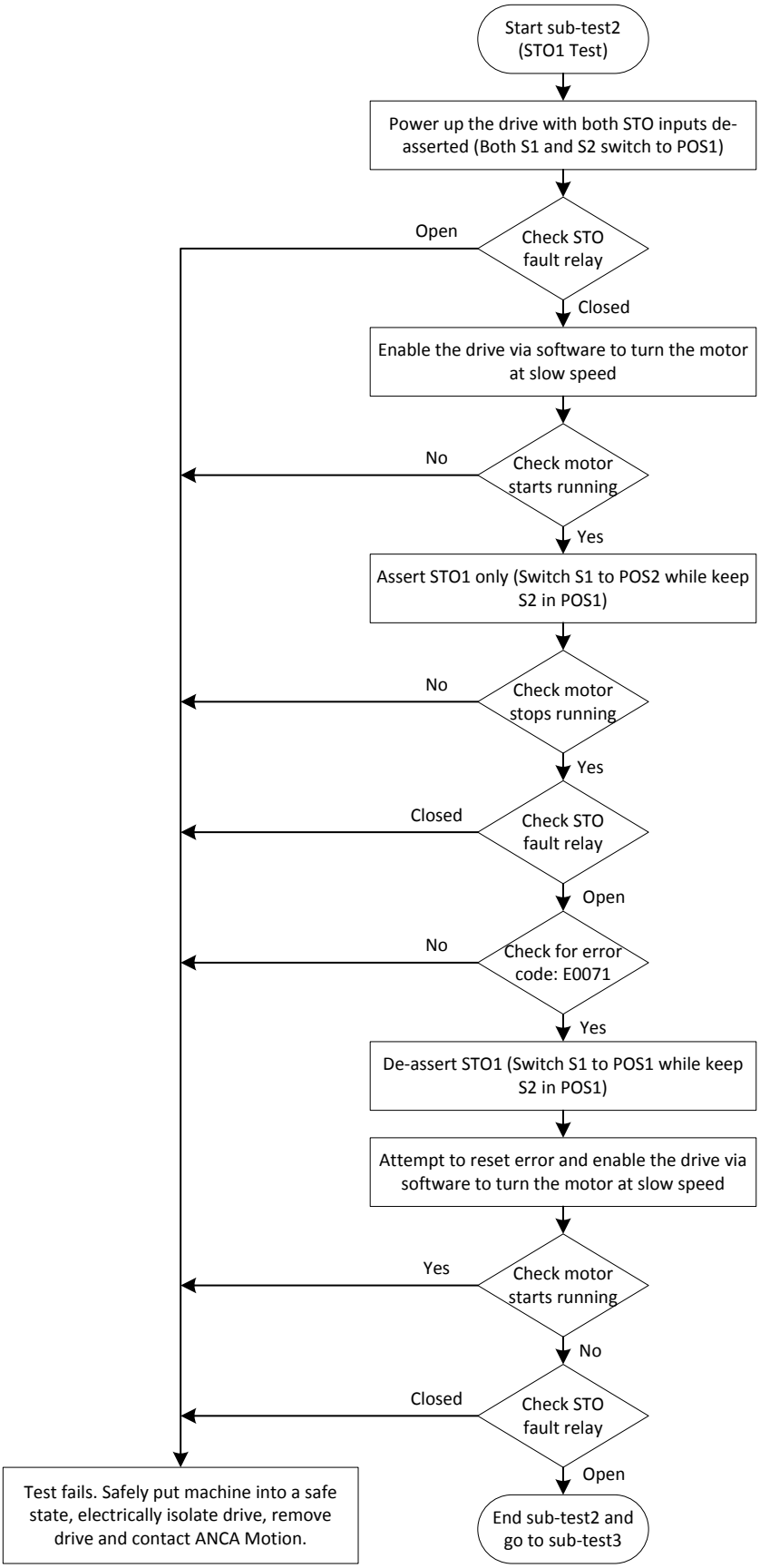


Figure 7-22 - STO Sub-Test 2

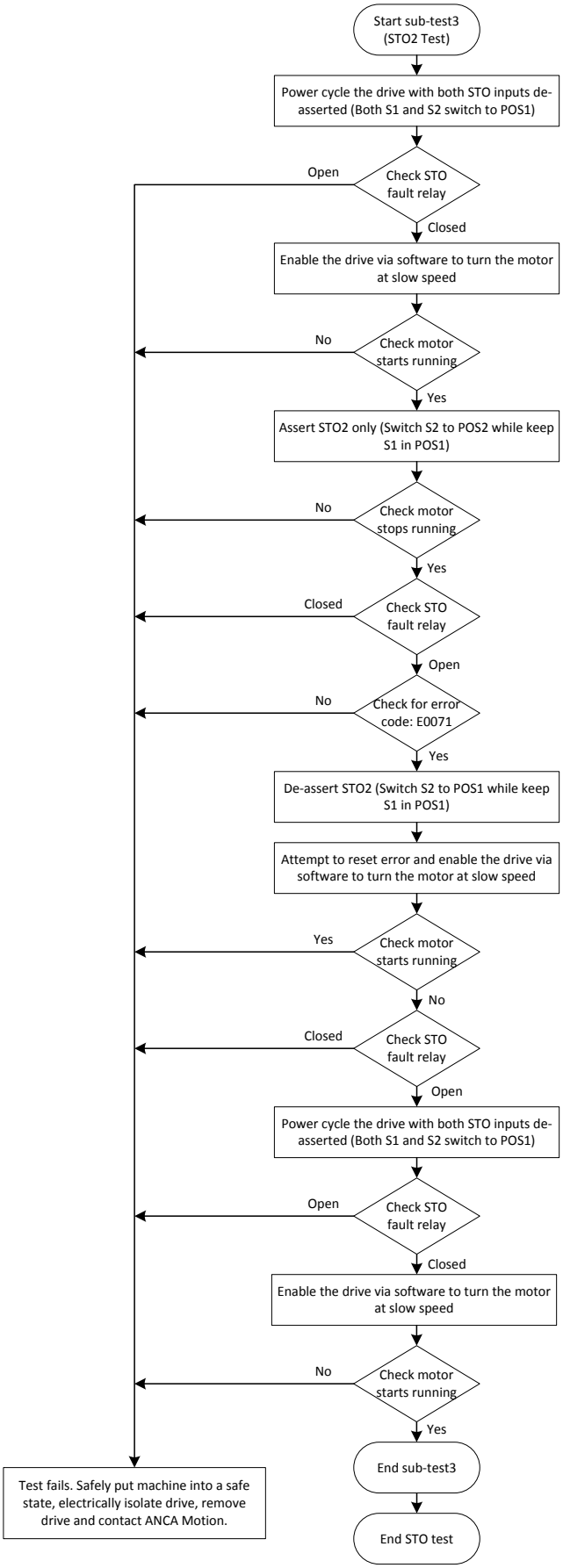


Figure 7-23 - STO Sub-Test 3

The test is now complete.

Warning: After the STO Commissioning Test is completed, it is imperative that extreme care is taken to assemble the drive connections as per wiring recommendations in this user guide.

7.5 Motor Brake Control

A motor brake can be connected to any of the digital outputs as previously described. The maximum current allowable is 500mA sink between all 6 digital outputs. Failure to observe this rating will result in damage to the drive.

Refer to section *6.9 Motor Brake Connection*.

7.6 Serial Communication Port

Use of the Serial Communication Port is not supported in the D21xx servo drive.

7.7 Ethernet Interface

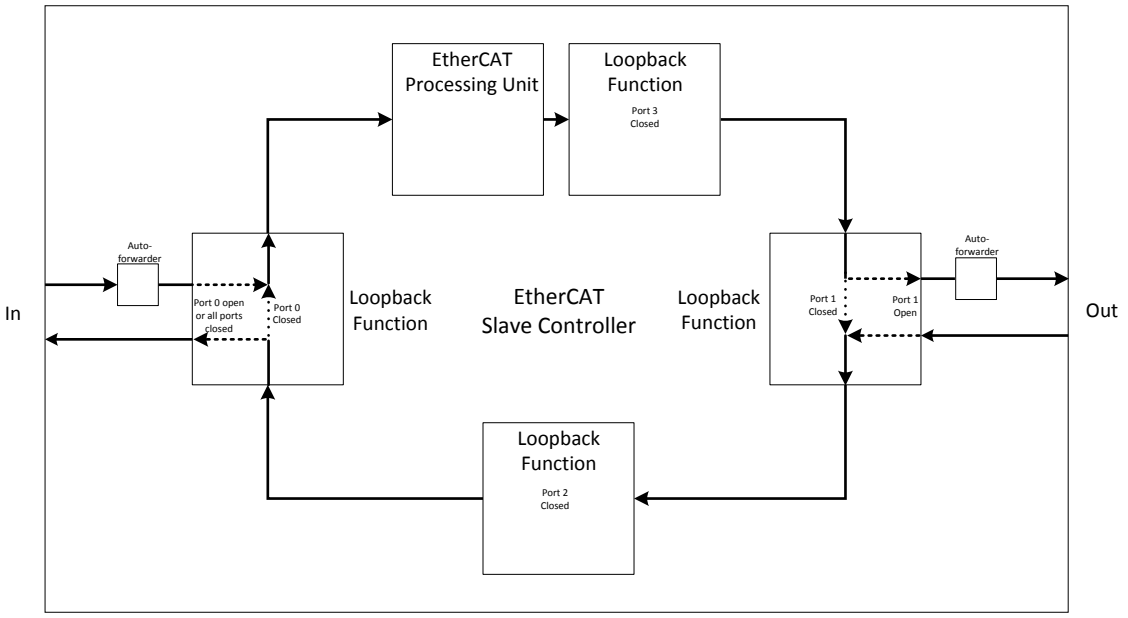
7.7.1 EtherCAT®[8]

AMD2000 supports the EtherCAT protocol with 'Servo Profile over EtherCAT' (SoE) and 'CANopen over EtherCAT' (CoE) capability based on the IEC61800-7 standard. This protocol provides deterministic communication over a standard 100Mbit/s (100Base-TX) Fast Ethernet (IEEE802.3) connection. This makes it suitable for the transmission of control and feedback signals between the AMD2000 and other EtherCAT enabled controllers.

AMD2000 functions as an EtherCAT slave controller, providing two ports (IN/OUT) for connection to other EtherCAT compliant equipment. This allows nodes to be connected in many configurations such as a ring, star, or tree, with EtherCAT's self-terminating technology automatically detecting breaks or an intended end of line. If only one port is used for EtherCAT operation, it must be the X1 (IN) port.

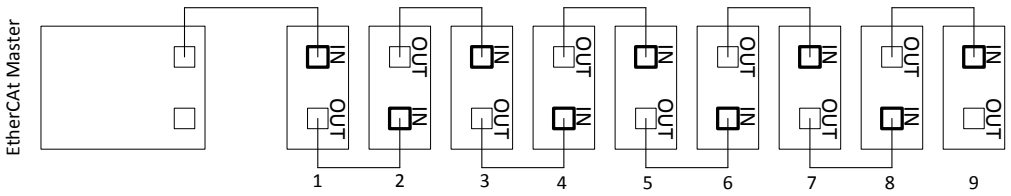
7.7.2 EtherCAT topology / Port assignment

[8] EtherCAT® is a registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany

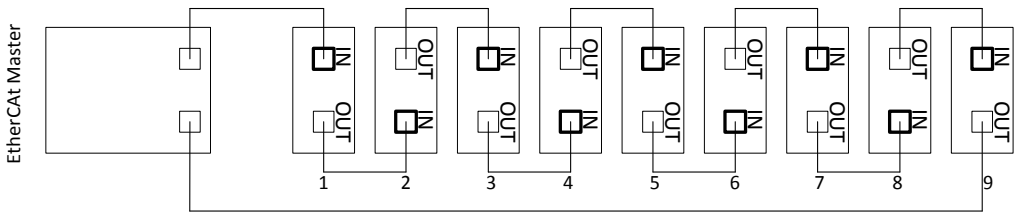


7.7.2.1 Possible EtherCAT Configurations are

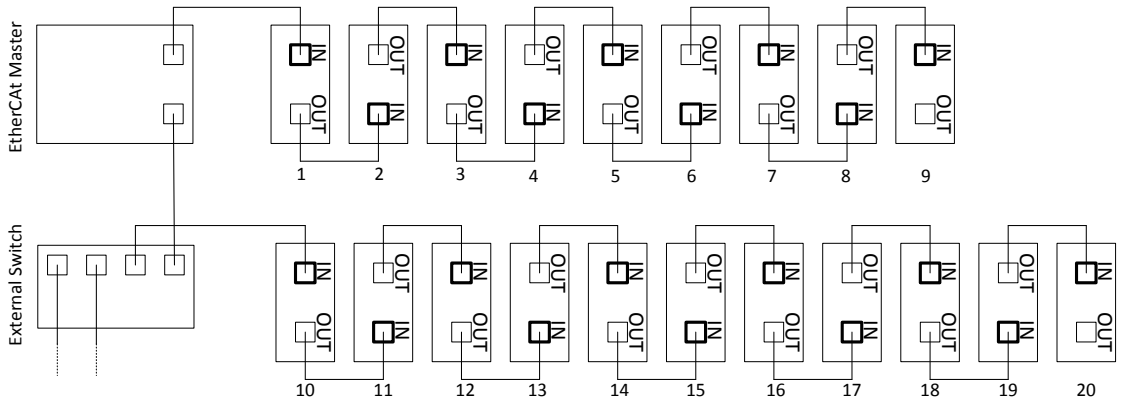
Straight Line Topology EtherCAT Network:



Ring Topology EtherCAT network:



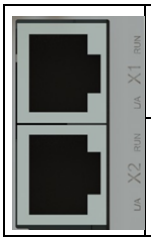
Multi-Branch EtherCAT network:



7.7.2.2 EtherCAT Configuration

EtherCAT configuration is usually performed using EtherCAT manager software. To assist with configuration, an EtherCAT Slave Information (ESI) file is provided in the firmware bundle. This .xml file describes the drive's capabilities to the EtherCAT manager.

7.7.2.3 EtherCAT Connectors

	X1	EtherCAT IN
	X2	EtherCAT OUT

7.7.2.4 EtherCAT Cables

To connect the AMD2000 drive to other EtherCAT devices the following types of cables must be used with 8P8C modular connectors. They are commonly referred to as "RJ45 shielded patch leads".

Cable	Name	Cable Screening	Pair Shielding
Cat 5e or Above	F/UTP	Foil	None
	SF/UTP	Screen and Foil	None

- TP = twisted pair
- U = unshielded
- F = foil shielding
- S = screened (braid type)

Either straight or crossover cables may be used. Recommended cables are listed in the accessories section. See *11.4.6 EtherCAT Cables* for more information.

7.8 DIP Buttons

Button	Label	Function
SW4	MODE	Holding during power up will force the device into bootstrap mode
SW3	UP	Reserved
SW2	DOWN	Reserved
SW1	SET	Holding during power up will force the device into bootstrap mode

Additional functionality may also be available depending on variant, refer to the related *AMD2000 Series Servo Drive - Configuration Guide* for more information.

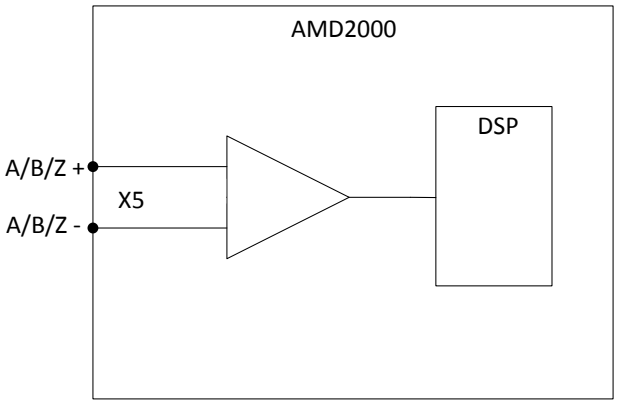
7.9 Motor Encoder Feedback

In the case where encoders are integrated into motors only those with internal reinforced insulation between hazardous voltage in the motor and encoder signal circuits can be used with the AMD2000 drive.

Connector	Pin Number	Label	Analogue Encoder[9]	Digital Incremental Encoder[10]
X5	1	Sin - / A-	Sin - / A-	-
	2	Sin + / A+	Sin + / A+	-
	3	Cos - / B-	Cos - / B-	-
	4	Cos + / B+	Cos + / B+	-
	5	Ref - / Z-	Ref - / Z-	-
	6	Ref + / Z+	Ref + / Z+	-
	7	A+	-	A+
	8	A-	-	A-
	9	B+	-	B+
	10	B-	-	B-
	11	Z+	-	Z+
	12	Z-	-	Z-
	13	9VDC	-	-
	14	5VDC	5VDC	5VDC
	15	GND	GND	GND

7.9.1 Analogue Encoder Interface

7.9.1.1 Idealized Drawing of the Analogue Encoder Circuit



[9] Encoder channel 1 is designed to support Sin/Cos encoders but can also be used for a secondary digital incremental encoder. This channel does not support the UVW wire-saving FOI feature. Please refer to the accompanying configuration guide for more information.
[10] Encoder channel 2 is designed to support digital incremental encoders only.

7.9.2 Analogue Encoder Cable

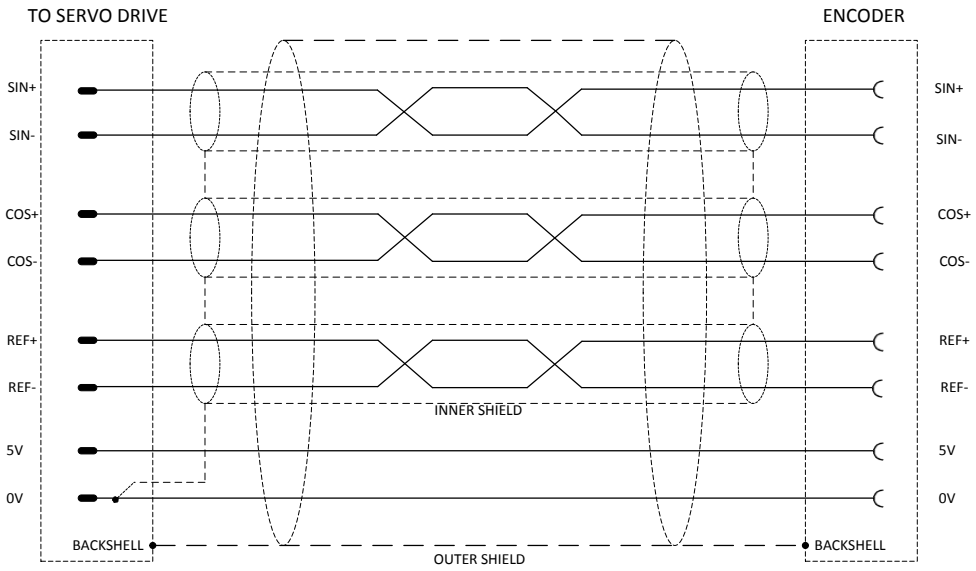
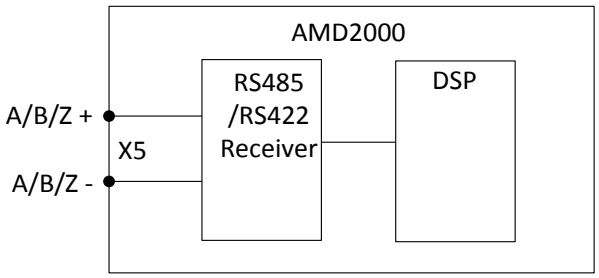


Figure 7-24 Typical Wiring Example of Analogue Incremental Encoder Wiring

7.9.3 Digital Encoder Interface

7.9.3.1 Idealized Drawing of the Digital Encoder Circuit



7.9.4 Digital Encoder Cable

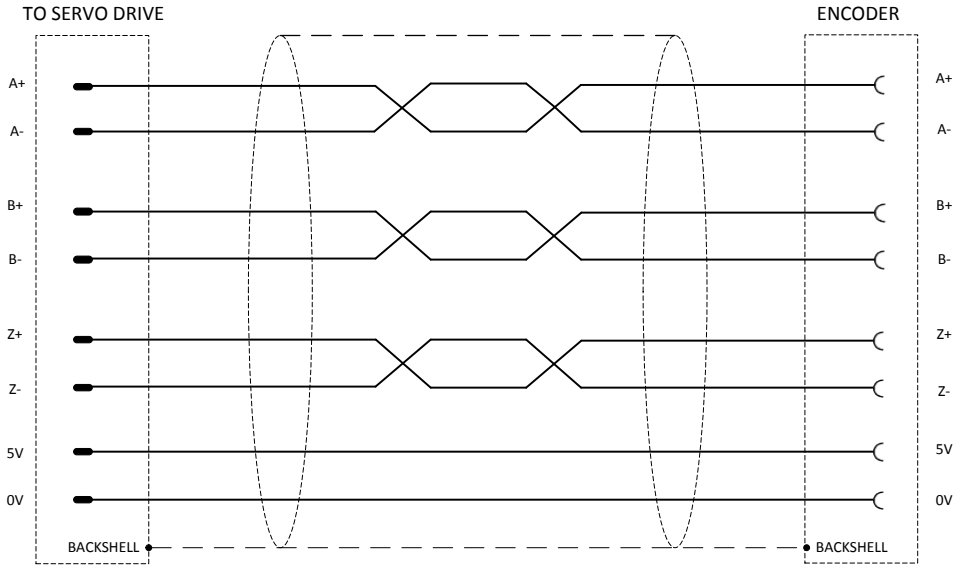
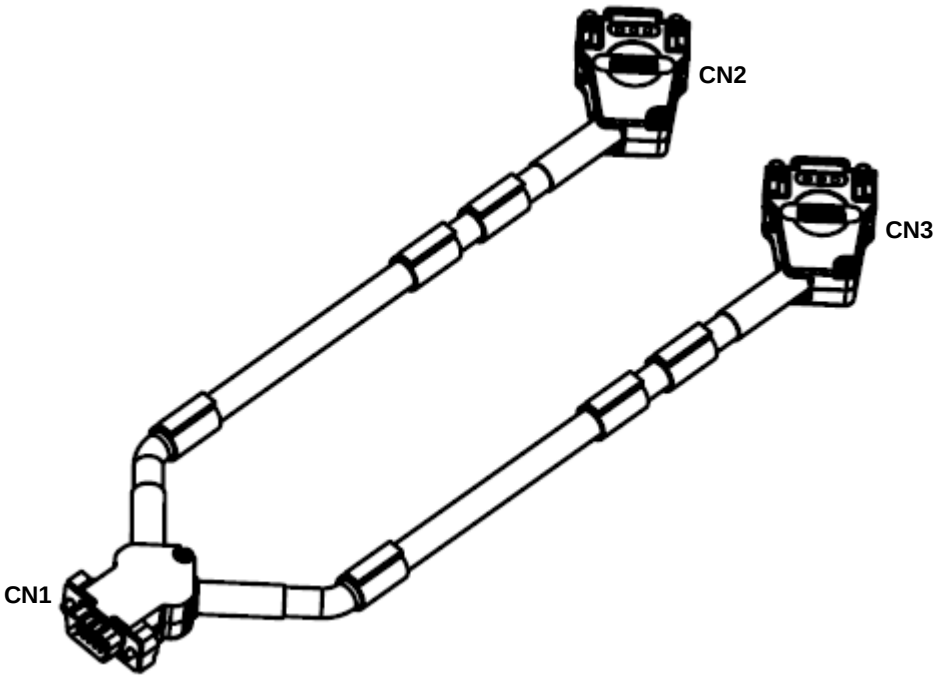


Figure 7-25 Typical Wiring Example of Digital Incremental Encoder Wiring

Recommended cables are listed in the accessories section *11.3.2 Encoder Cables*
.

7.9.5 Encoder Splitter Cable



Drive Connector (CN1)		Analogue Channel (CN2)		Digital Channel (CN3)	
Pin Number	Signal	Pin Number	Signal	Pin Number	Signal
1	SIN-/A-	1	SIN-/A-	NC	
2	SIN+/A+	2	SIN+/A+	NC	
3	COS-/B-	3	COS-/B-	NC	
4	COS+/B+	4	COS+/B+	NC	
5	REF-/Z-	5	REF-/Z-	NC	
6	REF+/Z+	6	REF+/Z+	NC	
7	A+	NC		7	A+
8	A-	NC		8	A-
9	B+	NC		9	B+
10	B-	NC		10	B-
11	Z+	NC		11	Z+
12	Z-	NC		12	Z-
13	E+9V	NC		NC	N/A
14	E+5V	14	E+5V	14	E+5V
15	EGND	15	EGND	15	EGND
Backshell	Shield	Backshell	Shield	Backshell	Shield

8 Installation Checklist

8.1 What this Chapter Contains

This chapter contains a pre power up checklist aimed at ensuring safe and successful initial power up of the drive.

8.2 Checklist

❒	The installation location satisfies the requirements in *4.3.1 Installation Site* and *10.5.3 Installation and Operation*
❒	An adequately sized protective earth connector is installed between the drive and the installation Earth Bar
❒	The required ventilation clearances around the drive have been observed per section *4 Mechanical Installation*
❒	An adequately sized protective earth connector is installed between the drive and the motor.
❒	Each protective earth conductor is connected to the appropriate terminal and is secured.
❒	The supply voltage does not exceed 264V rms between L1, L2 and L3.
❒	The input power cable is connected to the appropriate terminals and the conductors are secured.
❒	Appropriate supply circuit breakers and disconnect devices have been installed.
❒	The motor cable is connected to the appropriate terminals, the phase order is correct and the conductors are secured.
❒	The brake resistor cable (if applicable) has been connected to the appropriate terminals and the connections secure
❒	The motor cable and brake resistor cable (if applicable) have been routed away from other cables
❒	No power factor compensation capacitors have been connected to the motor cable
❒	A sinusoidal filter has been installed in between the motor armature output on the drive and the motor if required by the application
❒	All low voltage control cables have been correctly connected and are secure
❒	There is no dust or other foreign object inside the drive after installation (E.g. Due to cutting of cables etc.)
❒	All wiring conforms to applicable regulations and standards
❒	No physical damage is present to any component within the system

❒	The motor and all equipment connected to the drive is ready for start-up
❒	A risk assessment has been completed on entire machine and is considered by the user to be safe enough for operation
❒	Regeneration energy and power has been assessed and external resistor has been connected if required
❒	There are no shorts between encoder power supplies and encoder GND
❒	Possible load for all digital outputs does not exceed 500mA combined current sinking
❒	The STO Commissioning Test has been completed and PASSED following the instructions listed in *Section 7.4.8*, or if STO is not required, then the STO function has been disabled appropriately in accordance with *Section 7.4.5.5*.

9 Start-up

Please refer to the applicable configuration guides for this series of drive for parameter configuration, tuning and diagnostics.

- AMD2000 Series Servo Drive - SoE Configuration Guide
- AMD2000 Series Servo Drive - CoE Configuration Guide

10 Technical Data

10.1 What this Chapter Contains

This chapter contains information related to detailed specifications of the drive:

- Control Functions
- Interface Specifications
- Electrical Specifications
- Environmental Specifications
- Mechanical Dimensions and details
- De-Rating Curves
- Standards Compliance

10.2 Control Functions

Attribute	*Qualification*
10.2.1 Control Modes	
Linear control	Yes
Rotational control	Yes
Position control	Via EtherCAT (CoE/SoE) & Pulse Input
Velocity control	Via EtherCAT (CoE/SoE) & Analogue Voltage Input
Current/Torque control	Via EtherCAT (CoE/SoE)
Sinusoidal Permanent Magnet Servo Control	Yes
Sinusoidal Induction Motor Control	Yes
10.2.2 Thermal and over-current protection	
Inverter heat-sink temperature limit	80° C
Adjustable dynamic current limiting	Yes
Adjustable continuous over-current monitoring	Yes
Adjustable instantaneous over-current monitoring	Yes
Surge protection	Yes (300 VAC)
10.2.3 Self-Protection features	
Motor overload	Yes, see AMD2000 Series Servo Drive – CoE Configuration or SoE Configuration Guides for adjustment.
Over-travel limit exceeded	Yes
10.2.4 DC bus voltage control	

Bus voltage monitor	Yes
Bus regeneration brake chopper	Yes
Bus over/under voltage adjustable limits	Yes

10.2.5 Advanced control functions

DC Bus compensation	Yes
Backlash compensation	Yes
Probing	Yes
Pre-defined Drive Controlled Moves (DCM)	Yes – up to 64 move segments
Drive Controlled Homing (DCH)	Yes
Field Orientation Modes	• DQ Alignment • Preconfigured Offset • Acceleration Observer • Absolute
EtherCAT Slave Mode	Yes
Stand-alone Mode	Yes
Field Firmware Updates	Yes
Position Latch	Yes
Persistent Configuration Data	Yes (via EEPROM)
Continuous ADC Calibration	Yes

10.3 Interface Specifications

Attribute	*Qualification*
10.3.1 Digital I/O Supply	
Nominal Operating Voltage	24 VDC -15%/+20%
Maximum Current	500 mA
Short Circuit Protected	Yes (resettable fuse)
10.3.2 24V Digital Inputs	
Number of Inputs	8
Nominal Operating Voltage	24 V
Maximum Voltage	30 V
Minimum Input Must Detect Voltage	18 V
Maximum Must Not Detect Input Voltage	5 V
Input Current	20 mA
Input Impedance	1 kΩ
Maximum Propagation Delay	10 us
Isolated	Yes
10.3.3 24V Digital Outputs	
Number of Outputs	6
Output Type	Low side MOSFET switch
Nominal Operating Voltage	24 V
Maximum Operating Voltage	30 V
Maximum Sink Current	500 mA total for all 6 outputs while not exceeding 500 mA per output
Isolated	Yes
Short Circuit Protected	Yes
10.3.4 Differential Digital Inputs	
Voltage rating	3V (RS-422 compliant)
Number of Inputs	2 *(4 wires)*
Input Common-Mode Voltage Range	+12/-7 V
Terminating Resistance	120 Ω
Turn On Differential Threshold	+200 mV
Turn Off Differential Threshold	-200 mV
Maximum Propagation Delay	130 ns
Isolated	No

10.3.5 Differential Digital Encoder Output

Voltage rating	5V
Number of Outputs	3 x line driver (6 wires)
Minimum Output High Voltage single ended W.R.T GND	2.5 V @ 20 mA
Maximum Output Low Voltage single ended W.R.T GND	0.5 V @ -20 mA
Maximum Current	±20 mA
Isolated	No
Short Circuit Protected	No

10.3.6 Analogue Inputs

Number of Inputs	2
Input impedance (DC)	20 kΩ
Input Voltage (Nominal Range)	±10 V
Input Voltage (Absolute Maximum Range)	±12.64 V
Bandwidth	700 Hz
Isolated	No

10.3.7 Analogue Outputs

Number of Outputs	2
Output Voltage (Nominal Range)	±10 V
Output Voltage (Absolute Maximum Range)	±12.25 V
Output Current (Nominal)	+/-10 mA
Short circuit protection	Yes
Bandwidth	500 Hz
Isolated	No

10.3.8 Motor Position Feedback

Number of position feedback channels	2 Ch1: Analogue 1 Vpp Ch2: 5V Line Drive
Supported Encoders	Analogue Incremental Sin/Cos (1 Vpp) Digital Incremental (5V)

10.3.9 Encoder Channel 1

Interface Type	Analogue 1 Vpp
Supported Inputs	Sin, Cos, Ref (1Vpp)
1Vpp Commutation Track	Not Supported
1Vpp Terminating Resistance	120 Ω
1Vpp Full Scale Differential Input Voltage	1.6 Vpp
1Vpp Bandwidth	200 kHz

10.3.10 Encoder Channel 2

Interface Type	5V Line Receiver
Number of Inputs	3 (6 wires)
Input Common-Mode Voltage Range	+12/-7 V
Terminating Resistance	120 Ω
Turn On Differential Threshold	+200 mV
Turn Off Differential Threshold	-200 mV
Isolated	No
Bandwidth	1Mhz

10.3.11 Encoder Supply

Nominal Voltage	5VDC +-1% regulated supply 9VDC +-2.5% regulated supply
Maximum Current	400mA (5VDC) 500mA (9VDC)
Short Circuit Protection	Yes

10.3.12 Ethernet Interface

Protocol	EtherCAT
Baud Rate	100 Mb/s
Drive Profile Definition	SoE / CoE
Connector	Ethernet RJ-45

10.3.13 Modbus Interface[11]

Baud Rate	19200 b/s
Connector	RJ-45

[11] Not supported on D21xx

10.3.14 Drive Display	
Indicator	5 x 7-segment LED
Operator Interfacing	4 x DIP buttons

10.4 Electrical Specifications

		Catalogue Number	
		D2103	D2109
Attribute	***Symbol***	***Qualification***	
10.4.1 Power supply section			
Drive Input voltage	$U_{LN-(1\Phi)}$ $U_{LL-(3\Phi)}$	100~240VAC 220~240VAC	
Voltage fluctuation	U_{δ}	+/- 10%	
Input frequency	f_{LN}	50/60Hz	
Maximum input voltage to Protective Earth	$U_{L1,L2,L3-PE}$	264V AC	
Auxiliary input current	I_{LN}	500 mA	
Soft Start Relay		Internal	
10.4.2 Digital servo drive			
DC voltage	U_{DC}	$1.404 \times U_{LN-(1\Phi - 3\Phi)}$	
Max. output voltage	U_{aN1}	$0.90 \times U_{LN-(1\Phi - 3\Phi)}$	
Continuous output current	I_{aN}	3A rms	9A rms
One-minute overload capability	I_{aM}	110%	
Peak repetitive overload current	I_p	6A rms	12.9A rms
Max. Peak repetitive overload duration	t_p	1 sec	
Min. Peak repetitive overload interval	t_s	10 sec	
Current loop update rate	t_i	62.5 µsec	
Drive efficiency	η_D	>90%	
Nominal output power rating[12]		400 W	1.5 kW
Max. Output frequency (at nominal *U*LN)	f_{max}	500 Hz	

Warning: Upon start-up, the drive will have an initial increased current draw. The drive should not be power cycled more than once every 10 seconds.

[12] Specific power de-rating curves can be found in *10.8 Voltage and Temperature De-rating.*

	Catalogue Number	
	D2103	**D2109**
Attribute	***Qualification***	
10.4.3 Resolution		
Analogue to Digital	12 Bits	
10.4.4 Steady State Performance		
Precision at recommended operating conditions	±2 encoder counts	
10.4.5 Regenerative Braking		
Regenerative brake switching capacity	3A at U_{DC}	9A at U_{DC}
Internal Brake Resistor	40 Watts	60 Watts
External Brake Resistor	Optional	

10.5 Environmental Specifications

	Catalogue Number	
	D2103	**D2109**
Attribute	***Qualification***	
10.5.1 Storage		
Ambient Temperature	-20 to +65° C	
Relative Humidity	5 to 90%	
Storage dust and solid particles exposure limit	IEC 60664-1 Clean air pollution degree 2	
Within the specifications given above, also do NOT allow the packaged drive (in box) to exceed the following conditions according to IEC 60721-3-1: climatic conditions 1K5, mechanical stress class 1M3, chemical influences class 1C2 and sand and dust class 1S2.		
10.5.2 Transport		
Ambient Temperature	-20 to +65° C	
Relative Humidity	90% at 40° C	
Mechanical vibration	15 to 27 Hz at 0.35 mm displacement amplitude sinusoid, and 9.8m/s^2 from 27 to 150 Hz. When above 27 Hz this is category 2M1 according to IEC 60721-3-2	
Within the specifications given above, also do NOT allow the packaged drive (in box) to exceed the following conditions according to IEC 60721-3-2: climatic conditions 2K4, mechanical stress class 2M2, chemical influences class 2C2 and sand and dust class 2S2.		
10.5.3 Installation and Operation		
Permissible Ambient Temperature at rated continuous current I_{aN}	0 to +50° C[13]	
Maximum Ambient Temperature[14]	+55° C	
Relative Humidity	5 to 85% non-condensing	
Mechanical vibration	15 to 27 Hz at 0.35 mm displacement amplitude sinusoid, and 9.8m/s^2 from 27 to 150 Hz. This is between 3M1 and 3M4 according to IEC 60721-3-3	
Unusual environmental conditions	Not provided beyond 60146-1-1	
Maximum installation/operating altitude (with respect to mean sea level)	1000 m	
Operating dust and solid particles exposure limit	IEC 60664-1 Clean air pollution degree 2	
Within the specifications given above, also do NOT allow the drive to exceed the following conditions according to IEC 60721-3-3: climatic conditions 3K3, mechanical stress class 3M3, chemical influences class 3C2 and sand and dust class 3S2.		

[13] For the drive model with STO function exceeding an ambient temperature of 55°C will void the approval of the safety function certification to IEC 61800-5-2. See note 14, below, for de-rating details.

[14] De-rating is applied to the D2103 at some temperatures below 55°C, please refer to *10.8 Voltage and Temperature De-rating*.

10.5.4 Physical Characteristics

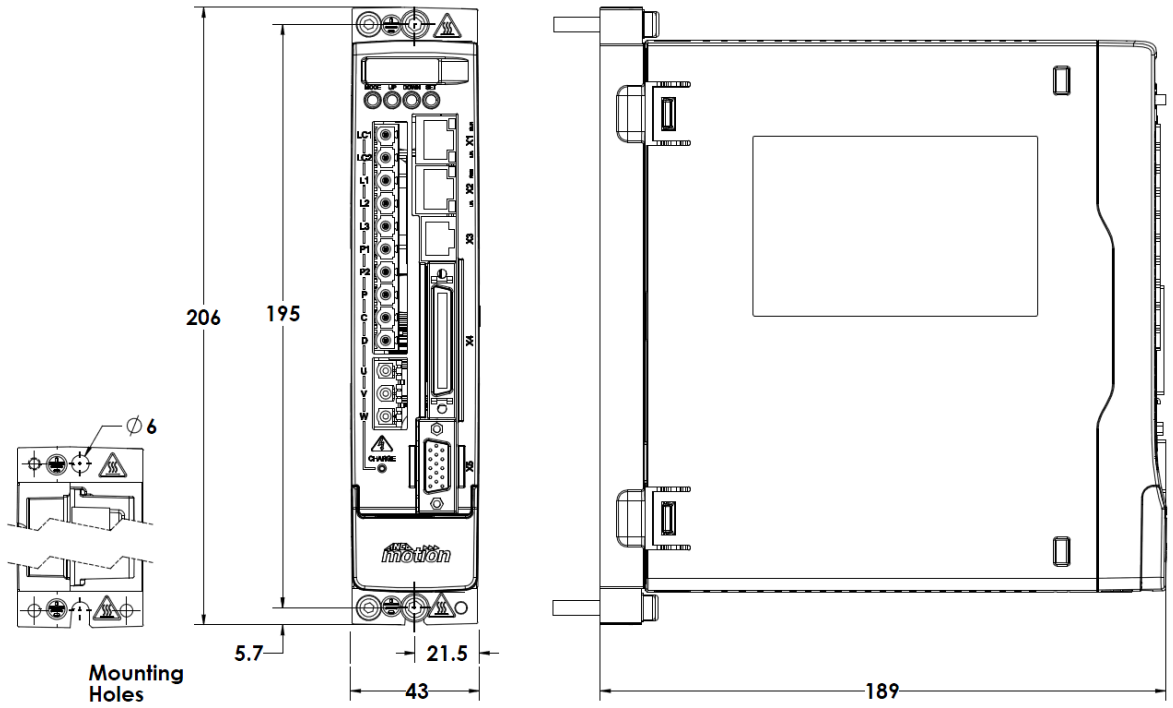
Degree of Protection	IP 20 in accordance with EN60529[15]	
Mounting position in Operation	Vertical	
Device Weight	1.25 kg	2.10 kg
Height (mm)	206	182
Width (mm)	43	60
Depth (mm)	189	189

10.5.5 Cooling

Fan Cooled	No	Yes
Heat generation @ full rated continuous current[16]	31 W	80 W

10.6 Dimension Drawings

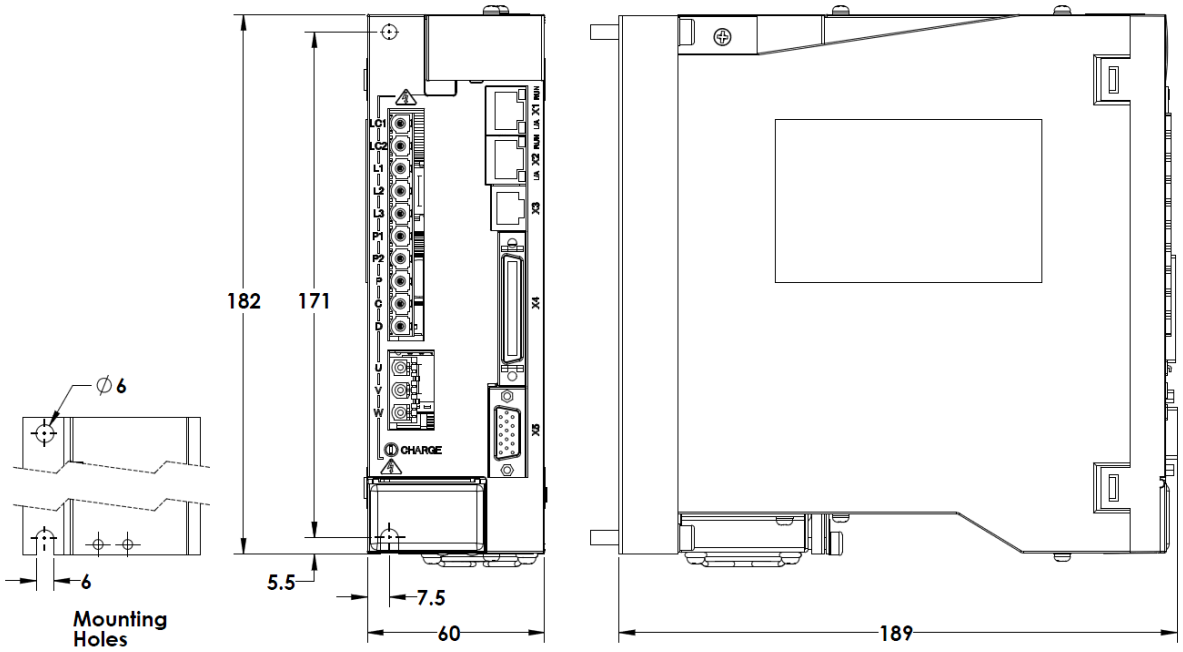
10.6.1 D2103 drive mounting hole positions and physical dimensions (mm)



[15] The top surface of cabinets/enclosures which are accessible when the equipment is energized shall meet the requirement of protective type IP3X with regard to vertical access only.

[16] This amount of heat energy needs to be removed from the equipment cabinet to prevent overheating

10.6.2 D2109 drive mounting hole positions and physical dimensions (mm)



10.7 24V Control Circuit Supply

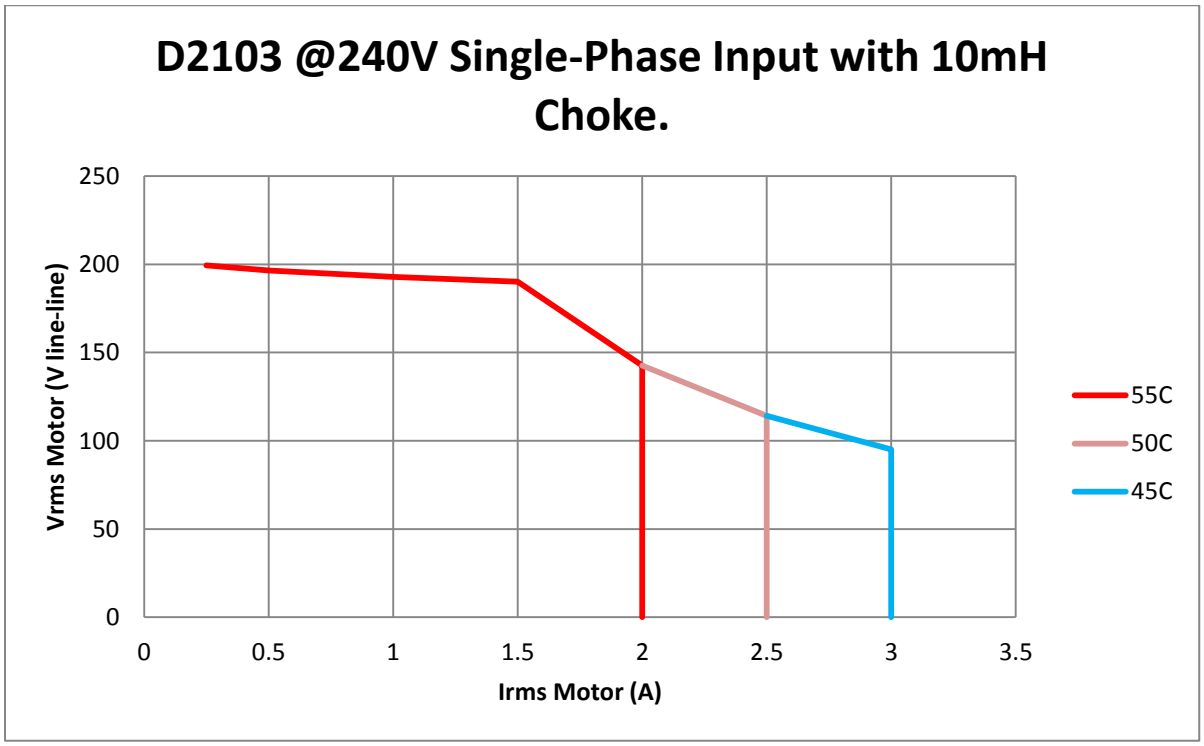
The maximum current that can be drawn from this supply is 500mA total. Note that if a motor with a brake is required this may be insufficient current to release the brake, so an external power supply will be required. If an external power supply is used it must be of the Separated Extra Low Voltage (SELV) type and approved to IEC 61950. Also note that if overloaded the poly-fuse in the drive will present a high resistance and there will no longer be 500mA available until the load is removed.

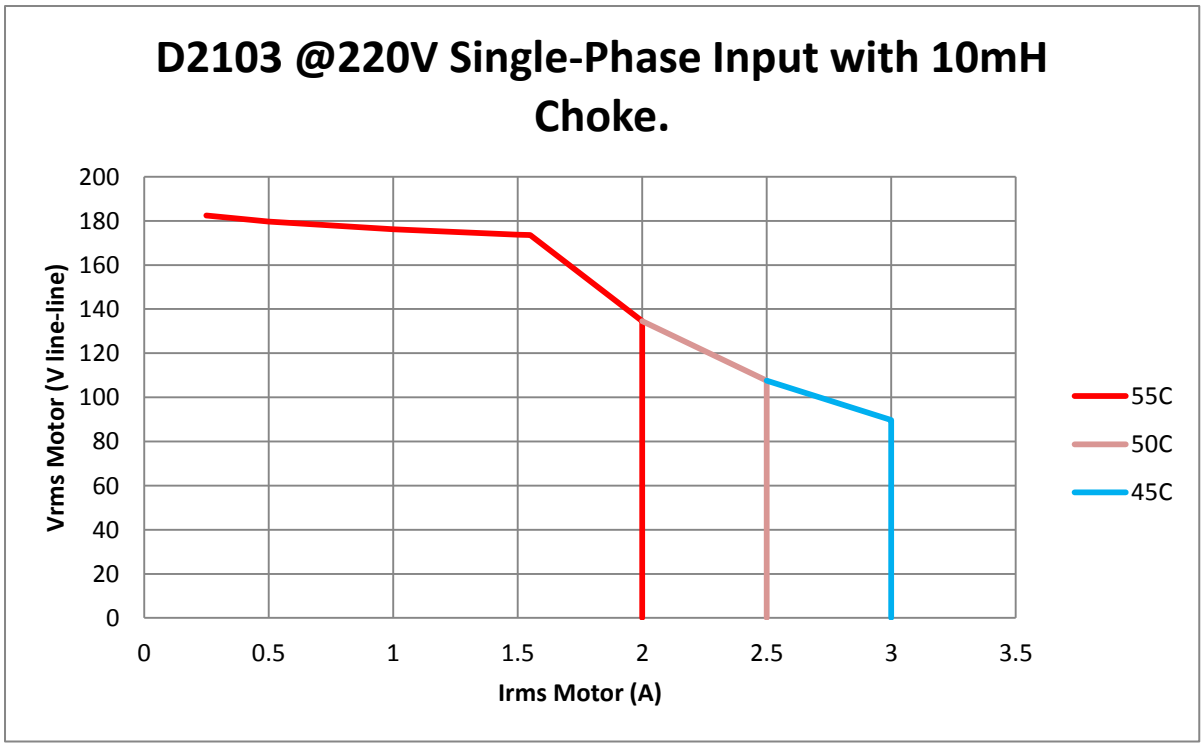
10.8 Voltage and Temperature De-rating

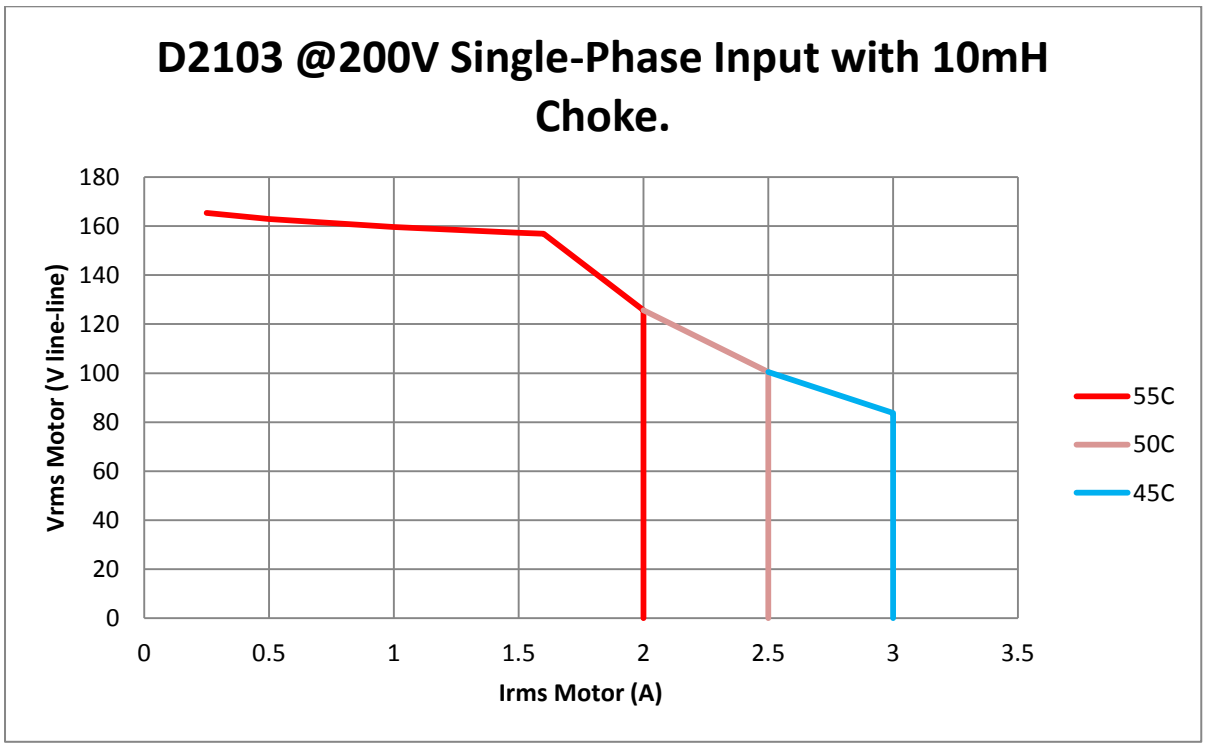
The curves below represent the operating range of the AMD2000 drive under varying electrical and environmental conditions. Input chokes specified correspond to *Installations conforming to the EMC Directive*. There is no temperature de-rating specified unless explicitly demonstrated.

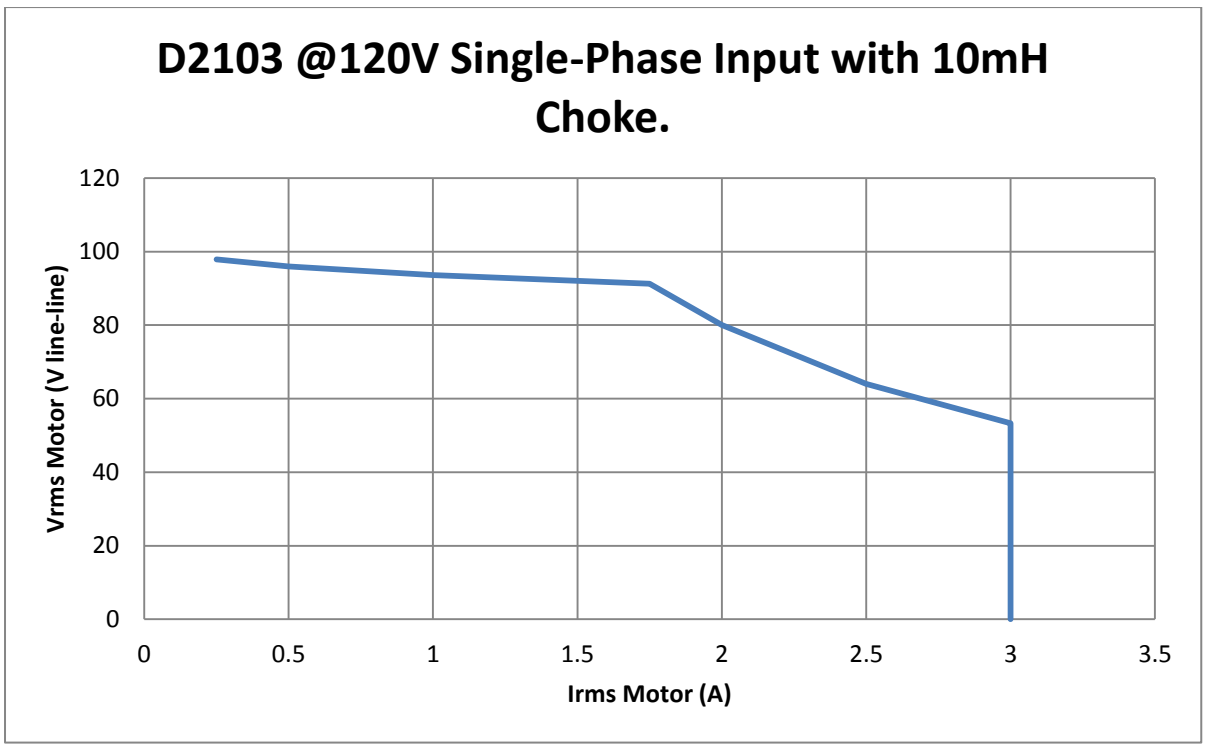
10.8.1 D2103 De-rating

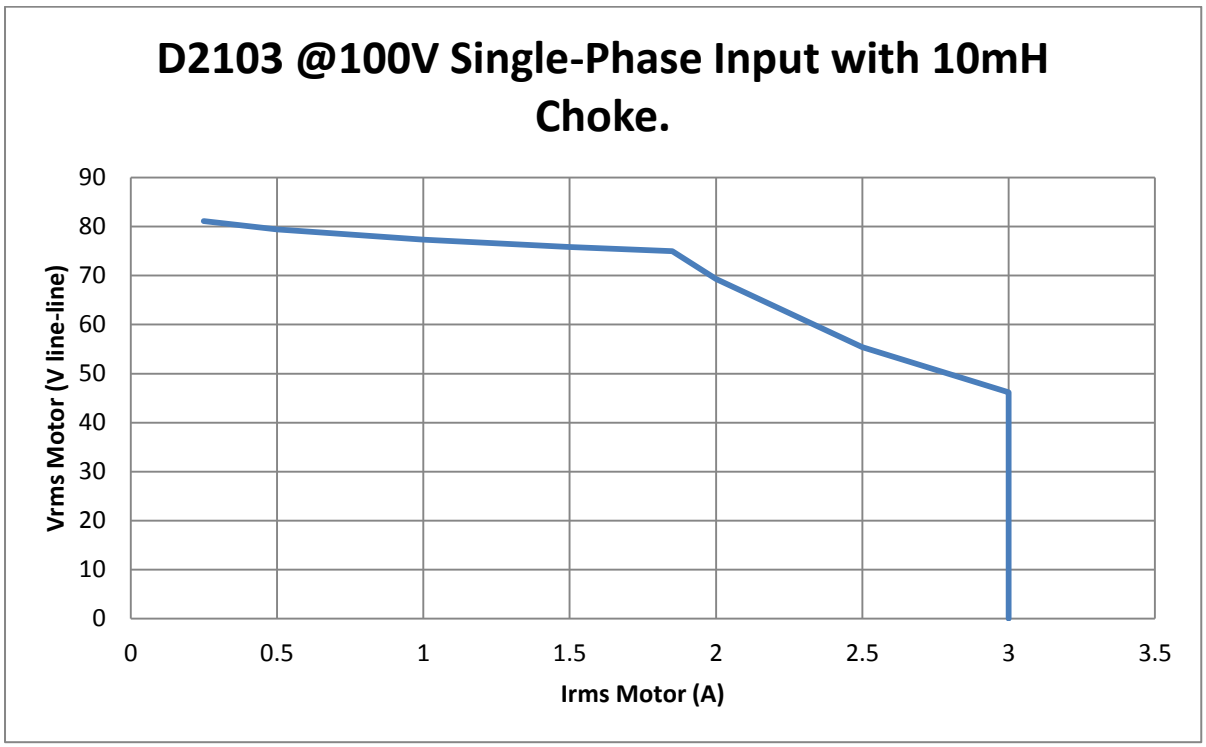
10.8.1.1 1-Phase



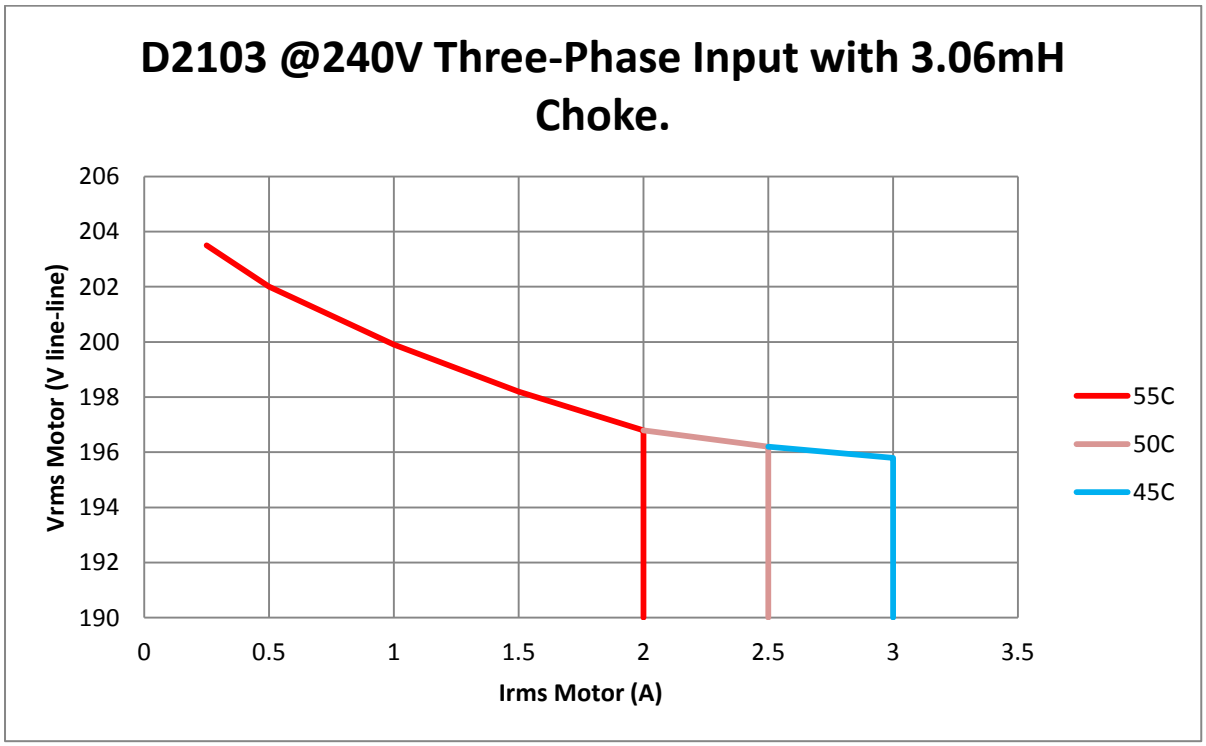


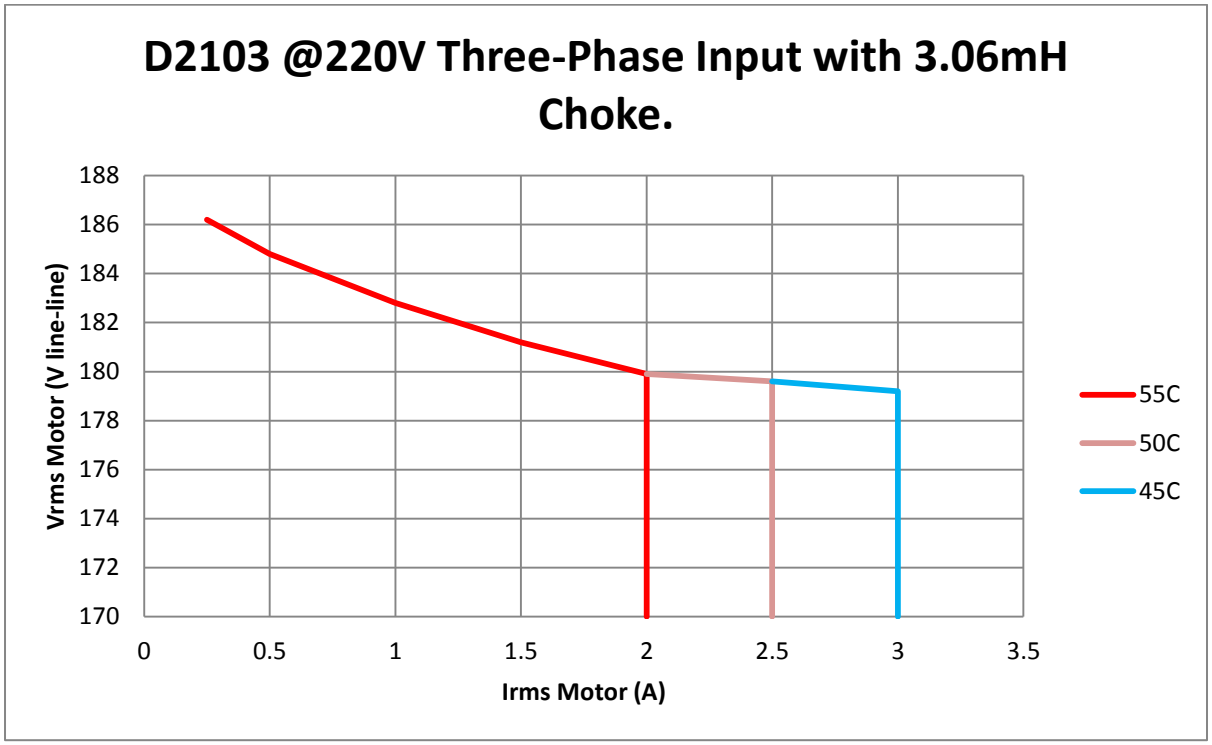

D2103 @200V Single-Phase Input with 10mH Choke.
Vrms Motor (V line-line)
180
160
140
120
100
80
60
40
20
0
0
0.5
1
1.5
2
2.5
3
3.5
Irms Motor (A)
55C
50C
45C

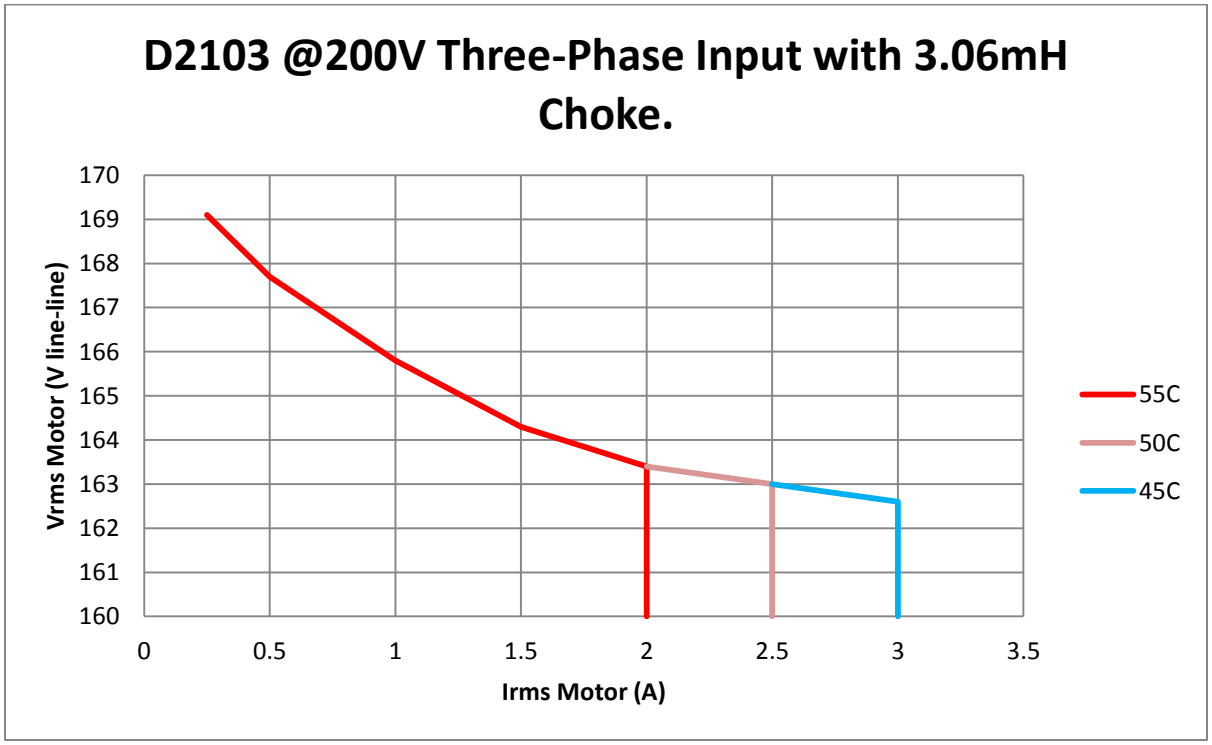

D2103 @120V Single-Phase Input with 10mH Choke.
Vrms Motor (V line-line)
120
100
80
60
40
20
0
0
0.5
1
1.5
2
2.5
3
3.5
Irms Motor (A)



10.8.1.2 3-Phase

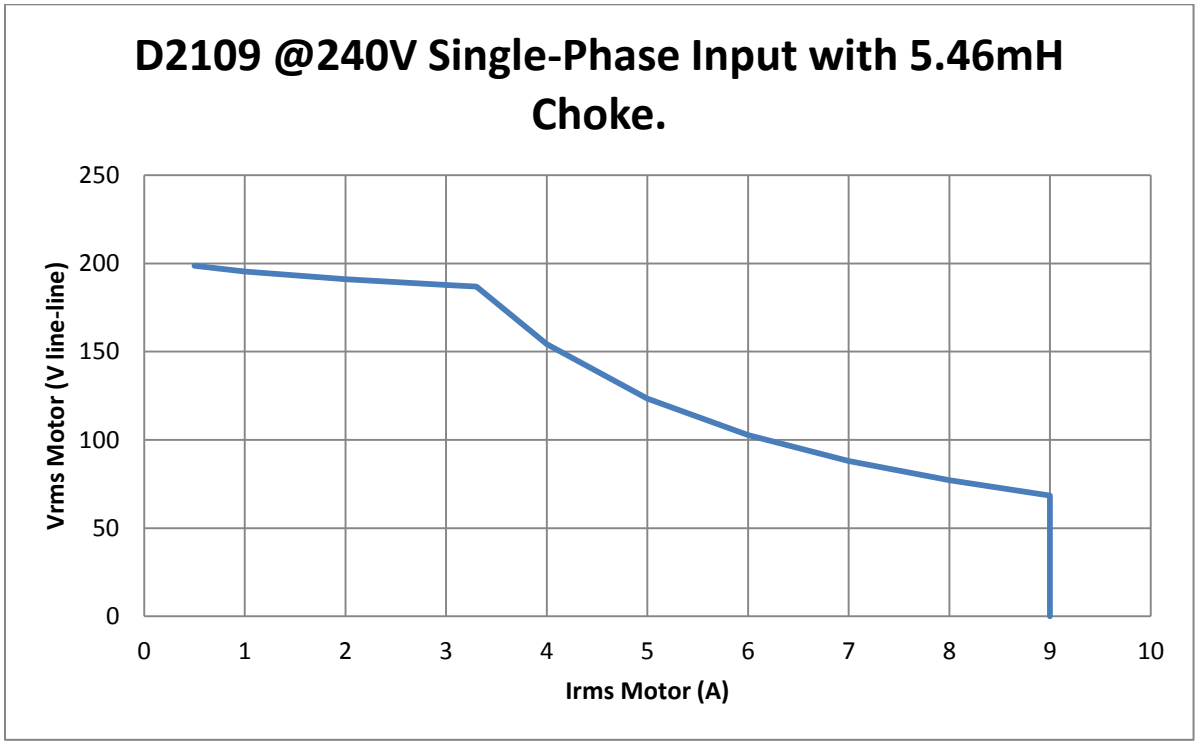


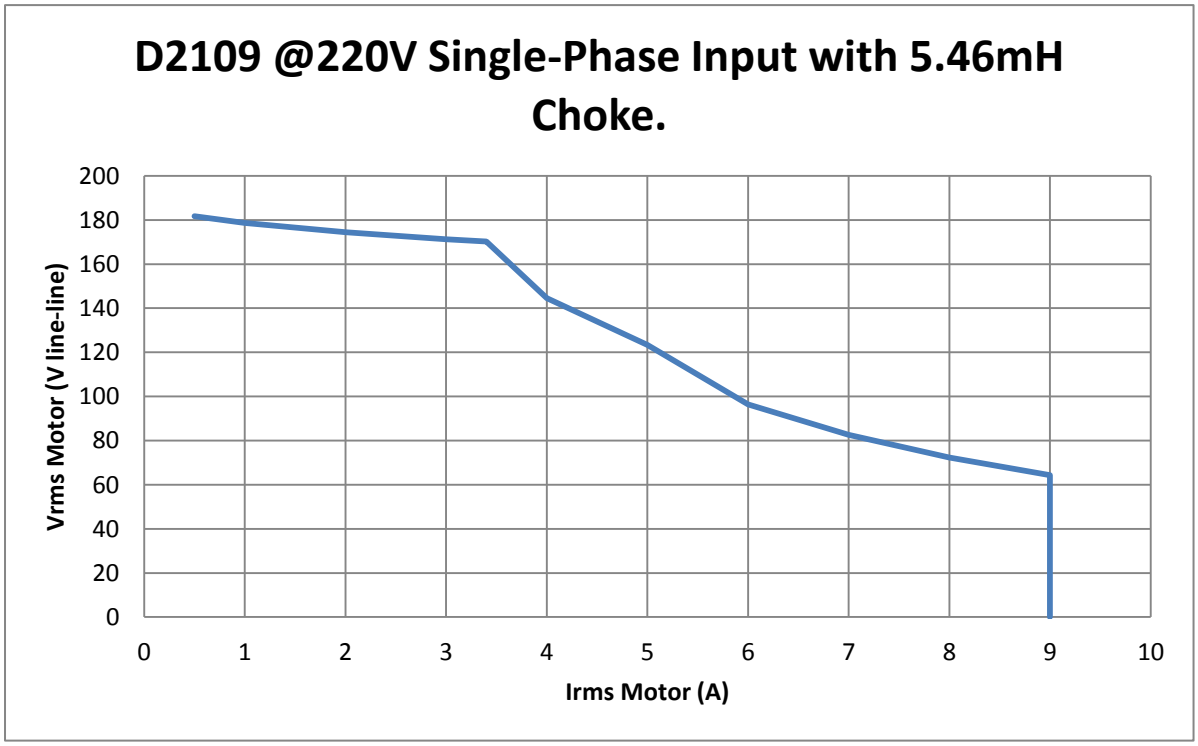

D2103 @220V Three-Phase Input with 3.06mH Choke.
Vrms Motor (V line-line)
188
186
184
182
180
178
176
174
172
170
0
0.5
1
1.5
2
2.5
3
3.5
Irms Motor (A)
55C
50C
45C

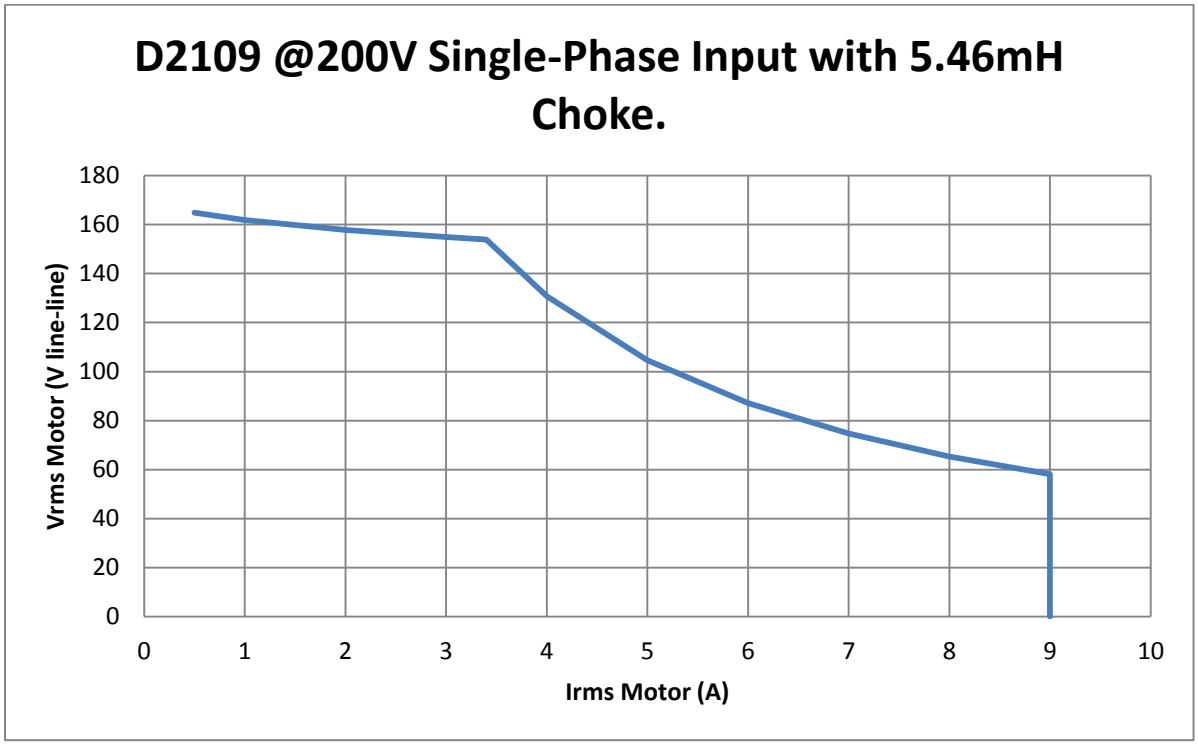

D2103 @200V Three-Phase Input with 3.06mH Choke.
Vrms Motor (V line-line)
170
169
168
167
166
165
164
163
162
161
160
0
0.5
1
1.5
2
2.5
3
3.5
Irms Motor (A)
55C
50C
45C

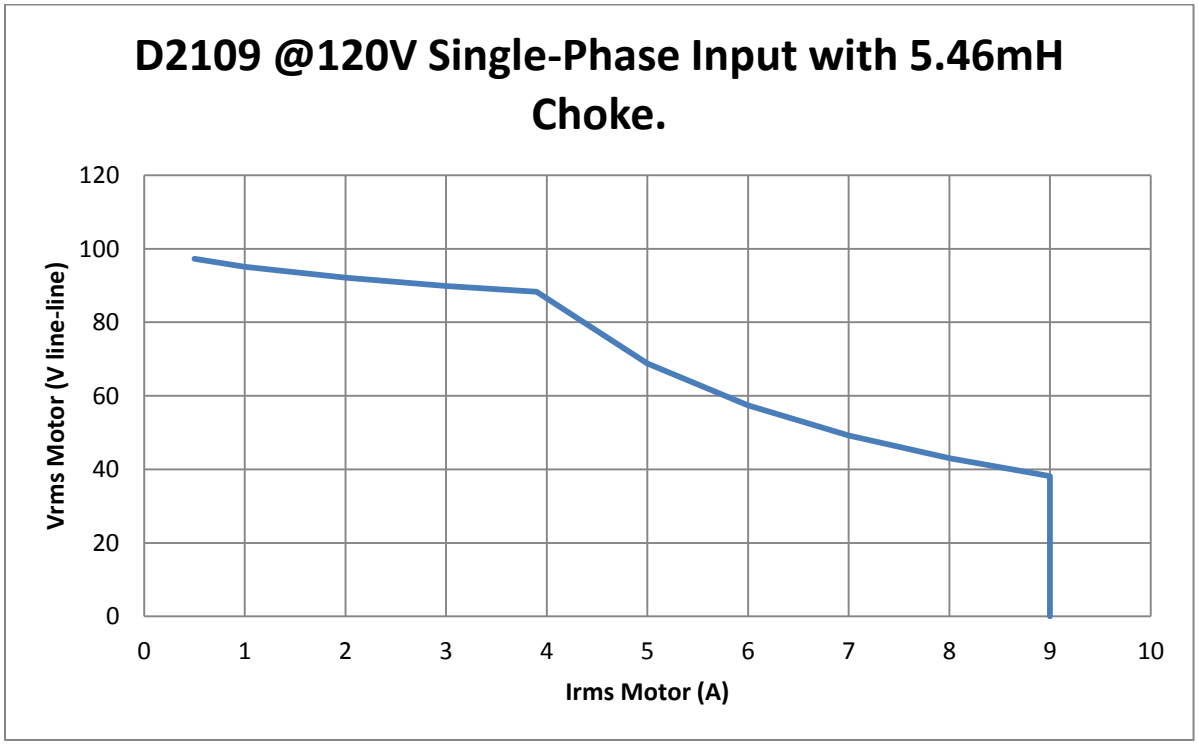
10.8.2 D2109 De-rating

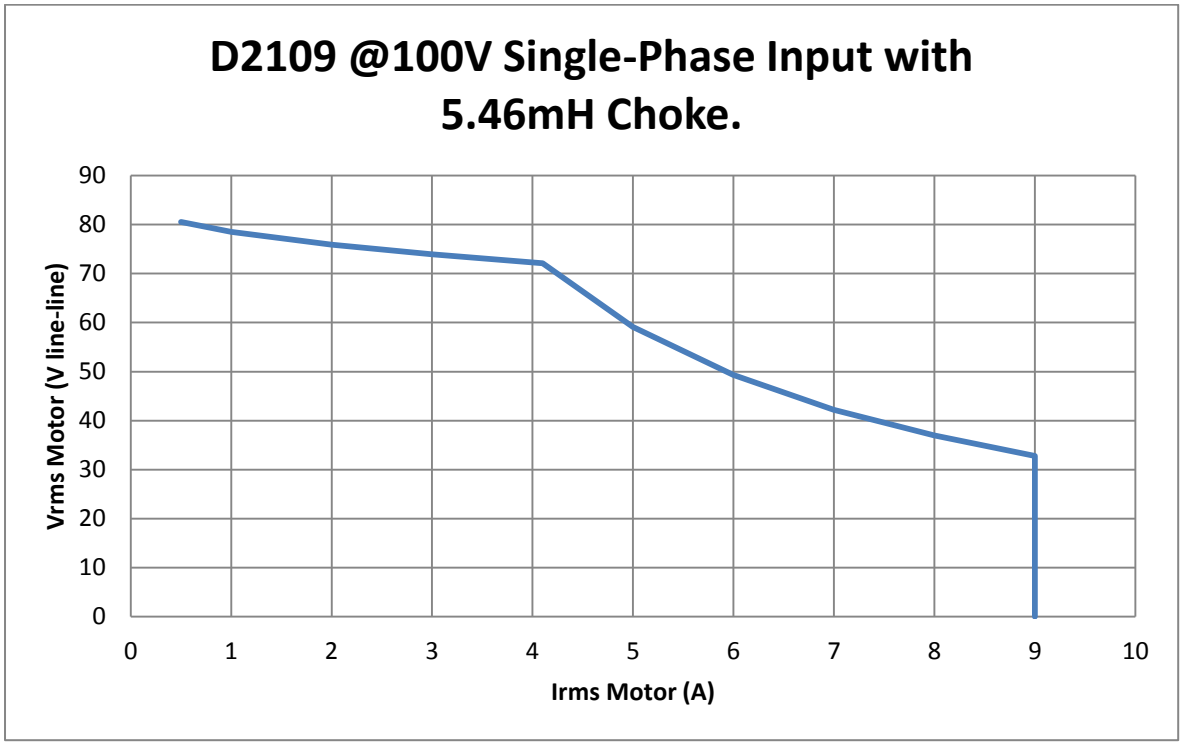
10.8.2.1 1-Phase



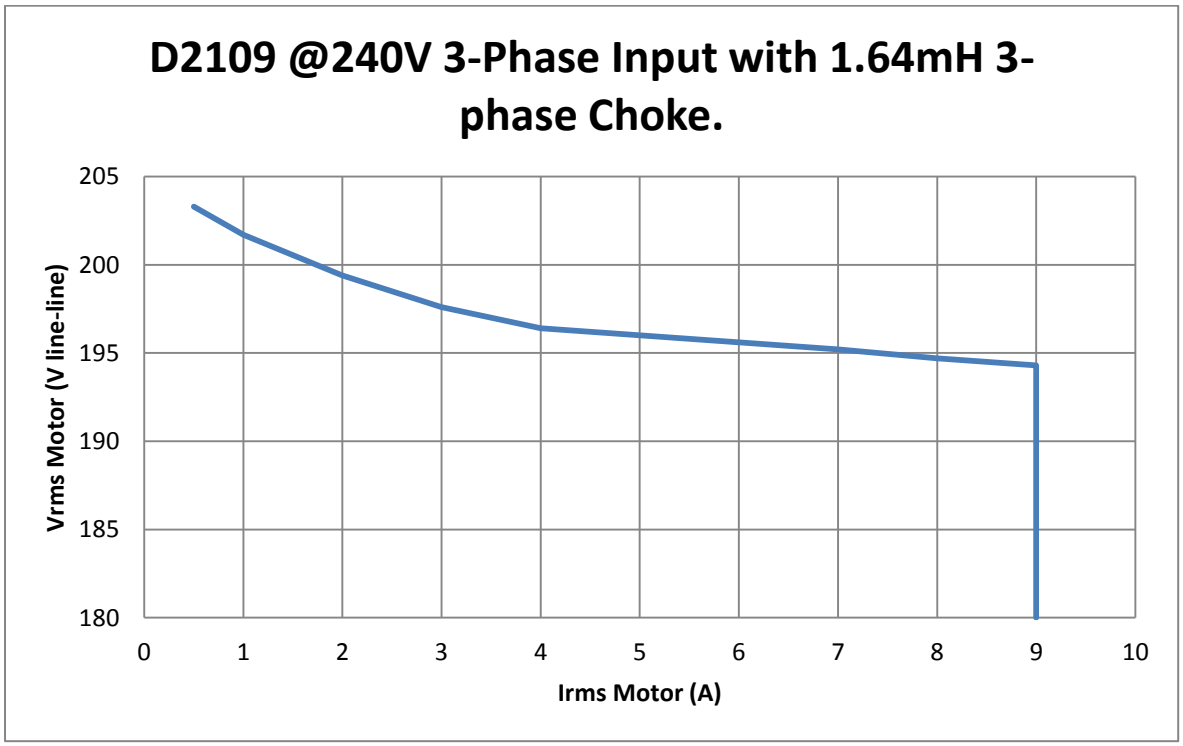


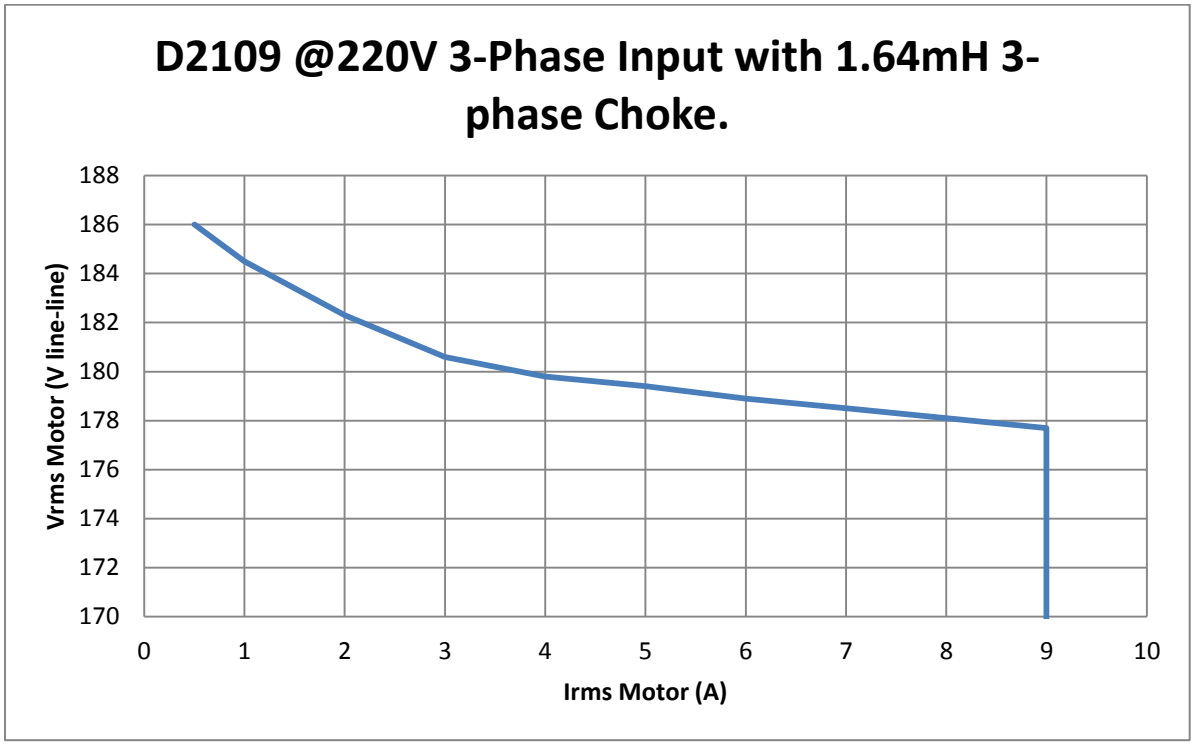

D2109 @200V Single-Phase Input with 5.46mH Choke.
Vrms Motor (V line-line)
180
160
140
120
100
80
60
40
20
0
0
1
2
3
4
5
6
7
8
9
10
Irms Motor (A)

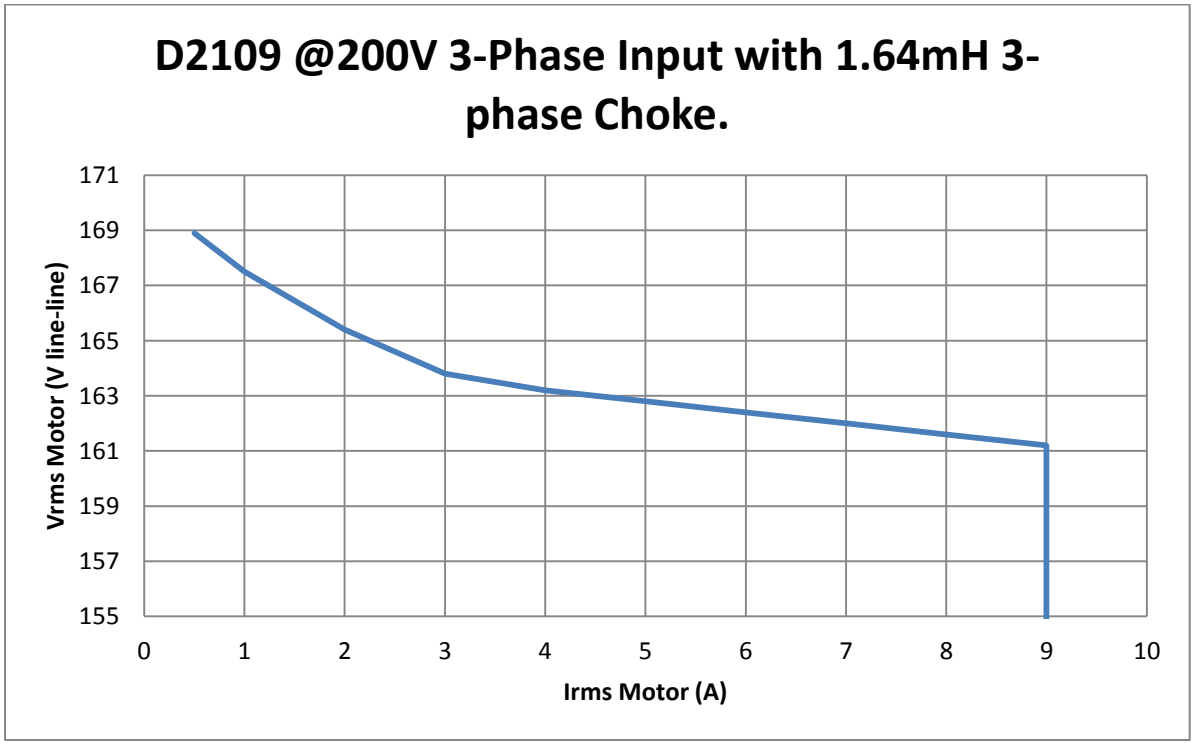

D2109 @120V Single-Phase Input with 5.46mH Choke.
Vrms Motor (V line-line)
120
100
80
60
40
20
0
0
1
2
3
4
5
6
7
8
9
10
Irms Motor (A)



10.8.2.2 3-Phase



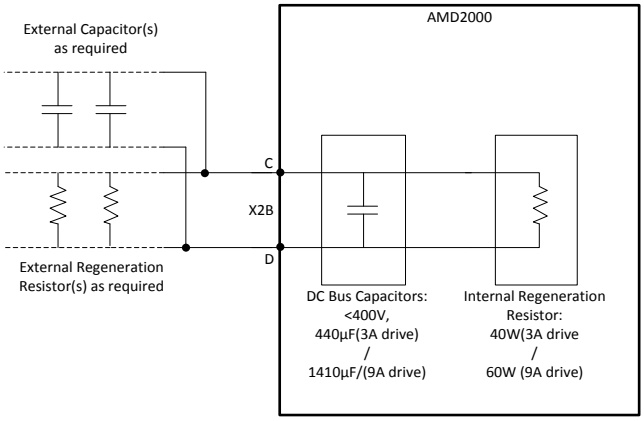




10.9 Regeneration Resistor

The D21xx drives have an inbuilt regeneration resistor. Regeneration refers to the process whereby when the motor is actively providing energy to the drive and then stops, the kinetic energy in the entire mechanical system connected to the shaft of the motor gets transferred to the bus capacitance in the drive, which increases the voltage. This happens because of the motor inductance. When the voltage on the bus capacitance exceeds 385V the drive will connect the internal regeneration resistor in addition to any external regeneration resistor that is provided by the user. The internal resistor is only capable of dissipating a power of 40W for the D2103 and 60W for the D2109. In addition to the power rating of the resistor to be observed the instantaneous energy maximum for each resistor must also be observed. This is 24.7 joules for the D2103 drive and 143 joules for the D2109. If there is more regeneration power than this is created then the user must connect an external resistor.

In addition to the energy limitation and average power limitation of the regeneration resistors, the rate of deceleration should not result in a DC Bus Overvoltage trip. This can occur if the instantaneous regenerated power exceeds the power being dissipated by the regeneration resistor. This is rarely an issue but can be a problem where very rapid decelerations at high retarding torques are desired. *Consult ANCA Motion* for advice if this is a concern.



10.9.1 Regeneration Resistor Selection, Regeneration Energy and Power

The starting points for the calculations regarding the required regeneration resistor are the two equations for kinetic energy in the system, and are dependent entirely on the application of the user.

Linear:

$$E = \frac{1}{2}mv^2$$

Where E = Energy in Joules
m = mass in kg
v = velocity in m/s

Rotational:

$$E = \frac{1}{2}J\omega^2$$

Where E = energy in Joules
J = moment of inertia in kgm^2
ω = angular velocity in rad/s

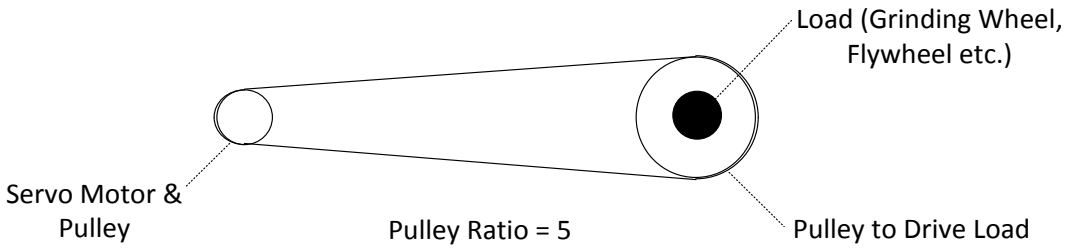
Once the kinetic energy in the system is found, the voltage rise due to the energy on the bus capacitance can be found:

$$\Delta V = \sqrt{(\frac{2E}{C})}$$

Where V = voltage in V,
E = Energy in Joules,
C = Capacitance in Farads

The power dissipated in the regeneration resistor(s) additionally depends on how often the user is stopping the torque output of the motor. For example, if the drive is operating in torque mode and a torque command is set to 0 from a non-0 value then the power dissipated is the kinetic energy in the system multiplied by the number of times per second the drive is going from this set point to 0 again.

Example 1:



The servo motor drives a load via two pulleys. The ratio is 1:5 from motor to load to provide a slower speed but higher torque.

Assuming the belt has negligible stored energy compared to the rest of the system and the load is rotational:

J_{eff} (effective moment of inertia) = $J_{motor}+J_{motor\ pulley} + \left(\frac{1}{5}\right)^2 (J_{load\ pulley} + J_{load})$

The energy stored in the system at the time the torque set point is reduced to zero is:

$$E = \frac{1}{2} J_{eff} \omega^2$$

(For the inbuilt brake resistors, this value must not exceed 24.7Joules for D2103 drive and 143 Joules for D2109 drive.)

The rise in voltage in this example is then

$$\sqrt{(\frac{2E}{C})}$$

Example 2:

The situation in example 1 has torque applied and then stopped twice per second. The power required for the regeneration resistor to dissipate all of the energy is

$$P = Ef = E * 2$$

10.10 Materials

Drive enclosure	The AMD2000 Drive chassis (main, sub, and fan) are stainless steel 304 with a silver paint finish. The AMD2000 Drive heat-sink is aluminium 6063 T5. The AMD2000 face cover main and PN panels are SABIC Resin 221R with a print finish on the main panel.
Packaging	Cardboard
Disposal	The drive contains raw materials that should be recycled to preserve energy and natural resources. The package materials are mostly environmentally compatible and recyclable. All metal parts can be recycled. The plastic parts can either be recycled or burned under controlled circumstances, according to local regulations. Most recyclable parts are marked with recycling marks. The electrolytic capacitors and the integrated power module are classified as hazardous waste within the EU and must be removed and handled according to local regulations. For further information on environmental aspects and more detailed recycling instructions, please contact your local ANCA Motion distributor.

10.11 Standards Conformity

Marking & Applicable Regulations	Standard	Certification Organisation	Drive	
			D2103	D2109
CE EC Machinery Directive 2006 /42/EC (Annex IIA) EC Electromagnetic Compatibility 2004/108/EC (Annex IV)	EN 61800-5-1: 2007 (Class I) EN 61800-5-2: 2007 EN 61800-3: 2004 (Category C3)	EC Type Examination Cert has been issued by **Projects etc. Pty Ltd**, as a Notified Body (**2241**) for the EU Machinery Directive	**No. 141006GRa dated 06/10/2014** 	**No. 141006GRa dated 06/10/2014** 
EtherCAT[17]	ETG 1000 series ETG 9001 ETG 1300	Note: the AMD2000 is a conforming EtherCAT device, but does not qualify as conformance tested**.** ANCA Motion self-determination of compliance.		
Those items in the drive with no applicable regulation, but to which standards have been applied.	Servo Profile over EtherCAT fieldbus profile (SoE). IEC 61800-7. IEC 61491, for serial data link real time communications in industrial machines.	ANCA Motion self-determination of compliance within certain limits.		

[17] EtherCAT® is a registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany

10.11.1 CE Declaration of Conformity

EC DECLARATION OF CONFORMITY

Manufacturer:	ANCA Motion Pty. Ltd. 1 Bessemer Road Bayswater North Victoria 3153 Australia	**Person Authorised to Compile the Technical File, and ANCA Motion's Authorised Representative in the EU (contract No. am-1000141, 29/08/2014):**	Mr. Jan Langfelder ANCA GmbH Aloise-Senefelder-Str. 4 68167 Mannheim, Germany Phone: +49 6213381012

In accordance with the following directives:

EC Machinery Directive 2006/42/EC (Annex IIA)
EC Electromagnetic Compatibility 2004/108/EC (Annex IV)

Herewith declare that the D2103 and D2109 servo drives of the AMD2000 series, when used in accordance with the manufacturer's instructions, conforms to the essential health and safety requirements of the Machinery Directive and conforms to the protection requirements of the EMC Directive by virtue of its design, construction and assessment. In support of this declaration the D2103 and D2109 servo drives have been evaluated as complying with the following harmonized standards and all appropriate associated standards:

Standard	Title	Ed./Date
EN 61800-5-2	International Standard for Adjustable Speed Electrical Power Drive Systems, Part 5-2: Safety Requirements – Functional	1st, 2007
EN 61800-5-1	International Standard for Adjustable Speed Electrical Power Drive Systems, Part 5-1: Safety Requirements – Electrical, thermal and energy	2nd, 2007
EN 61800-3	International Standard for Adjustable Speed Electrical Power Drive Systems, Part 3: EMC requirements and specific test methods	2nd, 2004

Such servo drives are suitable for use in machinery level applications seeking to independently certify to comply with MD and EMC D requirements via;

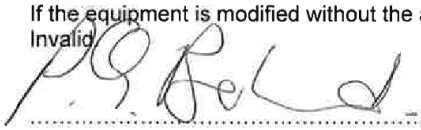
Standard	Title	Date
IEC 62061	Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems	2005
EN ISO 13849-1	Safety of machinery – Safety related parts of control systems –General Principles for design	2008

An EC Type Examination Cert (**No. 141006GRa dated 06/10/2014**) has been issued by Projects etc Pty Ltd, as a Notified Body (**2241**) for the EU Machinery Directive.

The Technical File for the Machinery Directive Compliance with 2006/42/EC is numbered **D-000093, and dated 02/10/2014 Revision 01**, and is held by the manufacturer.

The Technical Documentation for the EMC Compliance with 2004/108/EC is numbered **D-000092, and dated 02/10/2014 Revision 01**, and is held by the manufacturer.

If the equipment is modified without the agreement of the undersigned, this declaration becomes Invalid.



.....Date: 6th October, 2014

PATRICK GERARD BOLAND
Joint Managing Director, ANCA Pty Ltd,
Signed on behalf of ANCA Motion Pty Ltd
Melbourne, Australia

10.11.1.1 Safety Function Specifications (EN 61800-5-2 and associated)

The object of this standard (61800-5-2) is to specify requirements for adjustable speed Power Drive Systems (PDS) or their elements with respect to functional safety considerations. The D2103 and D2109 incorporate a **Safe Torque Off** function, and comply with the standard with the following provisions:

1. The drives are installed and maintained according to the instructions given in the user guide.

Function	PFHd (dangerous failures per hour)	SIL (62061)	PL (13849-1)	Proof Test Interval
Safe Torque Off	6.84E-9	3	e	10 years continuous use

10.11.1.2 Electrical Safety Specifications (EN 61800-5-1 and associated)

The object of this standard (61800-5-1) is to specify requirements for adjustable speed Power Drive Systems (PDS) or their elements with respect to electrical, thermal and energy safety considerations. The D2103 and D2109 are considered to be protective **Class I PDS**, and comply with the standard with the following provisions

1. The drives are installed and maintained according to the instructions given in the user guide.

10.11.1.3 EMC Specifications (EN 61800-3 and associated)

The object of this standard (61800-3) is to define the limits and test methods for a Power Drive System (PDS) according to its intended use, whether residential, commercial or industrial. The standard sets out immunity requirements and requirements for electromagnetic emissions as minimums within these different environments. The D2103 and D2109 are intended for use as **Category 3 PDS**, and have been tested and certified to comply for use within what 61800-3 defines as the second environment. The D2103 and D2109 comply with the standard with the following provisions:

1. The motor and control cables are selected according the specifications given in the user guide.
2. The drives are installed and maintained according to the instructions given in the user guide.
3. The maximum cable lengths are 15 metres.

Warning: A drive of category C3 is not intended to be used on a low-voltage public network which supplies domestic premises. Radio frequency interference is expected if the drive is used on such a network.

10.11.1.4 Definitions

First environment	Environment that includes domestic premises, it also includes establishments directly connected without intermediate transformers to a low-voltage power supply network which supplies buildings used for domestic purposes.
Second environment	Environment that includes all establishments other than those directly connected to a low-voltage power supply network which supplies buildings used for domestic purposes.
Category C3 Power Drive System	Category 3 is for a PDS of rated voltage less than 1000 V, intended for use in the second environment and not intended for use in the first environment.
Protective Class I	Equipment in which protection against electric shock does not rely on basic insulation only, but which includes an additional safety precaution in such a way that means are provided for the connection of accessible conductive parts to the protective (earthing) conductor in the fixed wiring of the installation, so that accessible conductive parts cannot become live in the event of a failure in the basic insulation.

10.11.2 EtherCAT®[18] Conformance Marking

An EtherCAT device conformance mark is attached to each drive in order to verify that the unit has been tested for compliance with the EtherCAT marking, indicator and performance guidelines covered by the ETG standards listed in section *10.11 Standards Conformity*. Future drive revisions intend to achieve “Conformance tested” marking by independent verification through an externally registered body.

[18] EtherCAT® is a registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany

11 Accessories

11.1 What this Chapter Contains

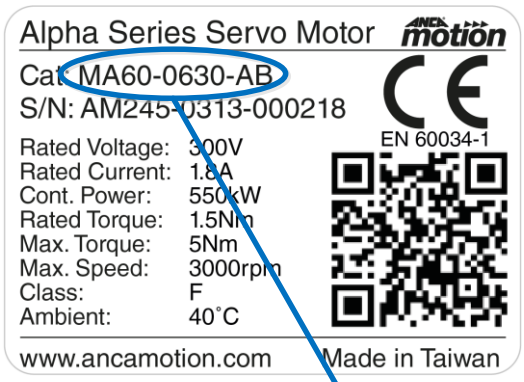
This chapter contains summarized information on accessories options available for this drive

- Ordering Information / Catalogue Number Interpretation
- Details of Accessories

For additional details, please refer to full catalogue and information available via *12.3 Product, Sales and Service Enquiries*

11.2 Motors

11.2.1 Motor Catalogue Number Interpretation



M A 6 0 - 0 6 3 0 - A B

Product
M: Motor

Series
A: Alpha Series

Frame Size
60: 60 mm square flange
80: 80 mm square flange
86: 86 mm square flange
130: 130 mm square flange

Rated Torque
06: 0.6 Nm
13: 1.3 Nm
24: 2.4 Nm
.. etc

Rated Speed
10: 1000 rpm
20: 2000 rpm
30: 3000 rpm
Refer to catalogue for full list

Feedback Type
A: Incremental Digital

Options
B: Brake

11.2.2 Motor Electrical Information Summary

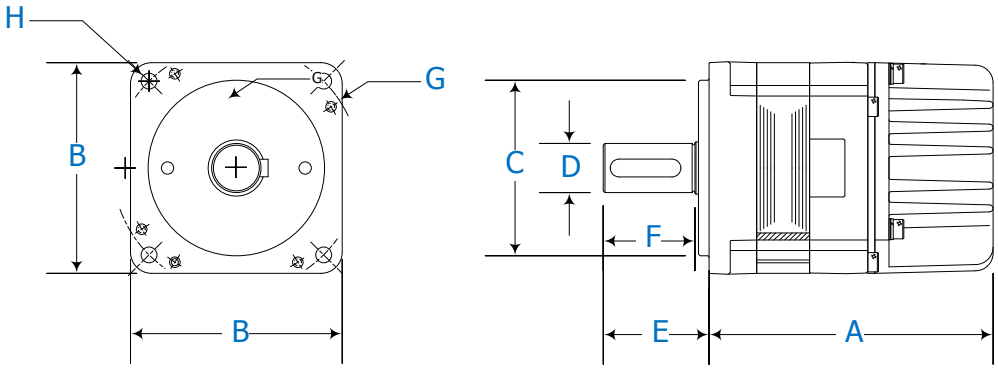
	Order code	Rated Torque (Nm)	Rated Speed (rpm)	Rated Power (W)	Rated Current (A)	Torque Constant (Nm/A)	Voltage Constant (V/krpm)	Max Current (A)	Max Speed 300 VDC bus (rpm)	Rotor Inertia (kg.cm2)	Stator Resistance (Ohm)	Stator Inductance (mH)	Motor Poles
AMD2000 D2103	MA60-630-A	0.64	3000	200	1.8	0.39	33	5.4	7000	0.17	7.5	16.2	8
	MA60-630-AB	0.64	3000	200	1.8	0.39	33	5.4	7000	0.22	7.5	16.2	8
	MA60-1330-A	1.27	3000	400	2.5	0.51	49.89	7.5	5000	0.28	5.6	14.5	8
	MA60-1330-AB	1.27	3000	400	2.5	0.51	49.89	7.5	5000	0.33	5.6	14.5	8
	MA86-2430-A	2.39	3000	750	3.4	0.78	54.3	10.2	5000	2.45	2.18	7.7	8
	MA86-2430-AB	2.39	3000	750	3.4	0.78	54.3	10.2	5000	2.58	2.18	7.7	8
	MA130-5310-A	5.25	1000	550	3.43	1.68	117.3	10.3	2000	6.26	3.58	18.33	8
	MA130-5310-AB	5.25	1000	550	3.43	1.68	117.3	10.3	2000	6.58	3.58	18.33	8
AMD2000 D2109	MA80-2430-A	2.39	3000	750	4.3	0.61	52.09	12.9	5000	0.94	2.1	8.63	8
	MA80-2430-AB	2.39	3000	750	4.3	0.61	52.09	12.9	5000	1.07	2.1	8.63	8
	MA130-4830-A	4.78	3000	1500	7.06	0.74	51.7	21.2	5000	6.26	0.65	3.58	8
	MA130-4830-AB	4.78	3000	1500	7.06	0.74	51.7	21.2	5000	6.58	0.65	3.58	8
	MA130-7220-A	7.16	2000	1500	7.57	1.06	72.5	22.71	4000	8.88	0.79	4.74	8
	MA130-7220-AB	7.16	2000	1500	7.57	1.06	72.5	22.71	4000	9.20	0.79	4.74	8
	MA130-9620-A	9.55	2000	2000	9.18	1.14	79.6	27.5	3500	12.14	0.58	3.78	8
	MA130-9620-AB	9.55	2000	2000	9.18	1.14	79.6	27.5	3500	12.46	0.58	3.78	8

11.2.3 Brake Motor Specific Information

Order Code	Brake Current (A)	Brake Active Time (ms)	Brake Release Time (ms)	Weight (kg)	Rotor Inertia (kg/cm^2)	Static Friction Torque (Nm)	Connector Type
MA60-1330-AB	0.262	17	32	0.4	0.049	2	N
MA86-2430-AB	0.43	35	25	0.65	0.129	3	N
MA130-5310-AB	0.816	27	76	1.1	0.324	20	C
MA80-2430-AB	0.43	35	25	0.65	0.129	3	N
MA130-4830-AB	0.816	27	76	1.1	0.324	20	C
MA130-7220-AB	0.816	27	76	1.1	0.324	20	C
MA130-9620-AB	0.816	27	76	1.1	0.324	20	C

N: Flying Lead (no connector) C: MS Connector

11.2.4 Motor Mechanical Information Summary

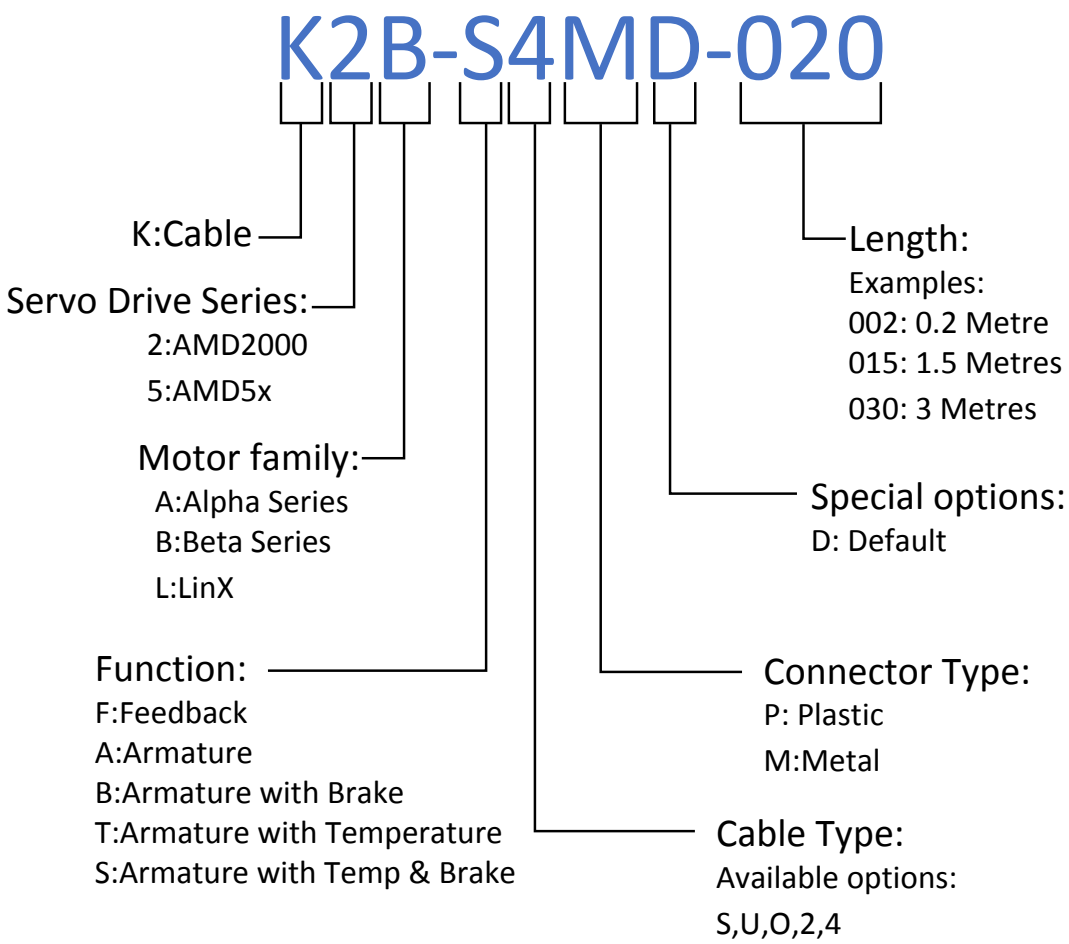


	Order code	A (mm)	B (mm)	C (mm)	D (mm)	E (mm)	F (mm)	G (mm)	H (mm)	Weight (kg)	IP Rating*[19]	Insulation Grade	Connector Style
AMD2000 D2103	MA60-0630-A	112.8	60	50	14	30	27	70	5.5	1.03	IP67	F (155°C)	AMP
	MA60-0630-AB	147.3	60	50	14	30	27	70	5.5	1.43	IP67	F (155°C)	AMP
	MA60-1330-A	132.8	60	50	14	30	27	70	5.5	1.37	IP67	F (155°C)	AMP
	MA60-1330-AB	167.3	60	50	14	30	27	70	5.5	1.77	IP67	F (155°C)	AMP
	MA86-2430-A	148	86	80	16	35	32	100	6.5	3.41	IP67	F (155°C)	AMP
	MA86-2430-AB	183.2	86	80	16	35	32	100	6.5	4.06	IP67	F (155°C)	AMP
	MA130-5310-A	164.8	130.4	110	22	58	52	145	9	6.47	IP67	B (130°C)	MS
	MA130-5310-AB	219.3	130.4	110	22	58	52	145	9	7.57	IP67	B (130°C)	MS
AMD2000 D2109	MA80-2430-A	139	80	70	19	40	37	90	5.5	2.47	IP67	F (155°C)	AMP
	MA80-2430-AB	174	80	70	19	40	37	90	5.5	3.12	IP67	F (155°C)	AMP
	MA130-4830-A	164.8	130.4	110	22	58	52	145	9	6.47	IP67	B (130°C)	MS
	MA130-4830-AB	219.3	130.4	110	22	58	52	145	9	7.57	IP67	B (130°C)	MS
	MA130-7220-A	183.8	130.4	110	22	58	52	145	9	8.08	IP67	B (130°C)	MS
	MA130-7220-AB	238.3	130.4	110	22	58	52	145	9	9.18	IP67	B (130°C)	MS
	MA130-9620-A	214.8	130.4	110	22	58	52	145	9	10.18	IP67	B (130°C)	MS
	MA130-9620-AB	269.3	130.4	110	22	58	52	145	9	11.28	IP67	B (130°C)	MS

[19] IP rating excludes electrical connector and shaft

11.3 Cables

11.3.1 Cable Catalogue Number Interpretation



Function	Cable type	Description
F	S	Feedback cable shielded incremental
A/B/T/S	0	Armature cable shielded 0.75mm2
A/B/T/S	S	Armature cable shielded 1.5mm2
A/B/T/S	U	Armature cable unshielded
A/B/T/S	2	Armature cable shielded 2.5mm2
A/B/T/S	4	Armature cable shielded 4mm2

11.3.2 Encoder Cables

11.3.2.1 Encoder Cables (Plastic/AMP)

Catalogue Number	Length
K2A-FSPD-020	2m
K2A-FSPD-030	3m
K2A-FSPD-050	5m
K2A-FSPD-100	10m

11.3.2.2 Encoder Cables (Metal/MS)

Catalogue Number	Length
K2A-FSMD-020	2m
K2A-FSMD-030	3m
K2A-FSMD-050	5m
K2A-FSMD-100	10m

11.3.2.3 Encoder Splitter Cable

Part Number	Length
619-0-01-0340	0.55m

11.3.3 Armature Cables

11.3.3.1 Shielded Armature Cables (Plastic/AMP)

Catalogue Number	Length
K2A-ASPD-020	2m
K2A-ASPD-030	3m
K2A-ASPD-050	5m
K2A-ASPD-100	10m

11.3.3.2 Shielded Armature Cables (Metal/MS)

Catalogue Number	Length
K2A-ASMD-020	2m
K2A-ASMD-030	3m

K2A-ASMD-050	5m
K2A-ASMD-100	10m

11.3.3.3 Shielded Armature Cables with Brake (Metal/MS)

Catalogue Number	Length
K2A-BSMD-020	2m
K2A-BSMD-030	3m
K2A-BSMD-050	5m
K2A-BSMD-100	10m

11.4 Other Accessories

11.4.1 I/O Interface Cable

Part Number	Description
ICN-1026-1190	AMD2000 I/O Interface Cable

11.4.2 I/O Interface Module

Part Number	Description
ICN-3077-1150	AMD2000 I/O Interface Module – I/O as described in *7 Control Wiring*
646-0-05-0723	AMD2000 I/O Interface Module with single-ended to differential inputs conversion on DI09 and DI10 – refer to 7.3.2.2.3 for detailed operation

11.4.3 I/O Interface Module Kit

Part Number	Description
619-0-00-0965	***AMD2000 I/O Interface Module Kit***
ICN-3077-1150	1 x AMD2000 I/O Interface Module
ICN-1026-1190	1 x AMD2000 I/O Interface Cable

11.4.4 I/O Connector

Part Number	Description
619-0-00-1187	***AMD2000 I/O Connector***
ICN-3077-1652	Plug, MDR 50 Way Male, Solder, Shielded
ICN-3077-1653	Backshell, MDR 50 Way, Screw Type

Warning: The IO Connector supplied in this way is not guaranteed by ANCA Motion for reliable STO delivery. Correct wiring and controls on manufacture of the cabling integrated with this connector will be necessary and must form part of the installer's own safety system requirements.

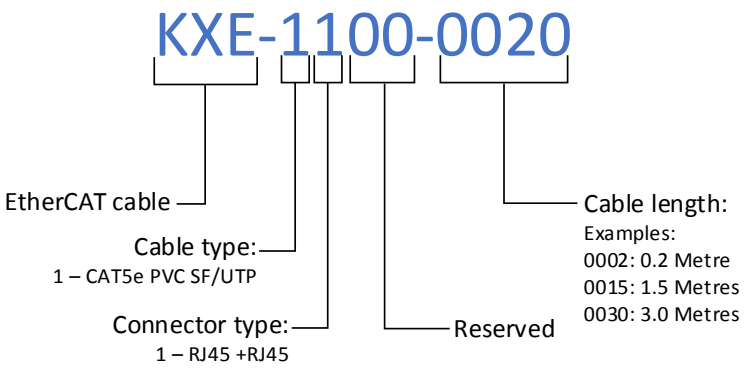
11.4.5 D21xx STO Override Plug

Part Number	Description
619-0-00-1285	D21xx STO Override Plug

Warning: The STO Override Plug de-asserts STO, allowing the drive to operate normally without safe system interference. Care should be exercised by installers and maintainers where machines are intended to operate safely using STO, as this device may be used to unintentionally override the STO function.

11.4.6 EtherCAT Cables

Product code



Examples

Catalogue Number	Description
KXE-1100-0002	Ethernet Cable, Cat 5e, SF/UTP, 0.2m
KXE-1100-0015	Ethernet Cable, Cat 5e, SF/UTP, 1.5m
KXE-1100-0030	Ethernet Cable, Cat 5e, SF/UTP, 3.0m

11.4.7 Armature Cable Shield Termination Kit

Part Number	Description
619-0-02-0957	AM2000 9A (D2109) Armature Cable Shield Termination Kit
619-0-00-1028	AM2000 3A (D2103) Armature Cable Shield Termination Kit

11.4.8 EMI Filters

Part Number	Description
ICN-3096-1665	Schaffner FN 3270H-10-44
ICN-3096-1667	Schaffner FN 3270H-20-44
ICN-3096-1676	Schaffner FN 350-8-29
ICN-3096-1674	Schaffner FN 350-20-29

11.4.9 Line Reactors

Part Number	Description
ICN-3096-1670	Hammond Power Solutions CRX07D6AC
ICN-3096-1671	Hammond Power Solutions CRX0014AC
ICN-3096-1672	Hammond Power Solutions CRX0014BC

11.4.10 DC Chokes

Part Number	Description
ICN-3096-1661	Hammond Manufacturing 159ZJ

11.5 Starter Kits

11.5.1 D2103 SoE Starter Kit

Part Number	*Description*
619-1-xx-0971	***D2103 SoE Starter Kit***
D2103-2S2-A	D2103 SoE Servo Drive
MA60-0630-A	Alpha Series Servo Motor
K2A-FSPD-020	Alpha Motor Cable
K2A-ASPD-020	Alpha Motor Cable
ICN-1026-1097	Ethernet Cable, Cat 5e, SF/UTP, 1m

11.5.2 D2109 SoE Starter Kit

Part Number	**Description**
619-1-xx-0972	***D2109 SoE Starter Kit***
D2109-2S2-A	D2109 SoE Servo Drive
MA80-2430-A	Alpha Series Servo Motor
K2A-FSPD-020	Alpha Motor Cable
K2A-ASPD-020	Alpha Motor Cable
ICN-1026-1097	Ethernet Cable, Cat 5e, SF/UTP, 1m

11.5.3 D2103 CoE Starter Kit

Part Number	*Description*
619-2-xx-0971	***D2103 CoE Starter Kit***
D2103-2C2-A	D2103 CoE Servo Drive
MA60-0630-A	Alpha Series Servo Motor
K2A-FSPD-020	Alpha Motor Cable
K2A-ASPD-020	Alpha Motor Cable
ICN-1026-1097	Ethernet Cable, Cat 5e, SF/UTP, 1m

11.5.4 D2109 CoE Starter Kit

Part Number	Description
619-2-xx-0972	***D2109 CoE Starter Kit***
D2109-2C2-A	D2109 CoE Servo Drive
MA80-2430-A	Alpha Series Servo Motor
K2A-FSPD-020	Alpha Motor Cable
K2A-ASPD-020	Alpha Motor Cable
ICN-1026-1097	Ethernet Cable, Cat 5e, SF/UTP, 1m

Note: To use any of the STO Starter Kits you will additionally need to order one of these connection options:

1. 619-0-00-0965 – AMD2000 I/O Interface Module Kit
2. 619-0-00-1187 – AMD2000 I/O Connector

Warning: The IO Interface Module Kit is guaranteed for reliable STO operation and has been certified as part of AM's STO Safety Function CE certification procedure. The installer must connect their own external safety system to the interface module according to the appropriate safety standards.

Warning: The IO Connector is not guaranteed for reliable STO operation as the IO needs to be suitably manufactured with cabling/wiring and tested for reliability. It is the responsibility of the installer to ensure that IO Connector and attached cabling/wiring is reliable as part of the installer's own safety system requirements.

12 Additional Information

12.1 What this Chapter Contains

This chapter contains information on product support and feedback:

- Maintenance and repairs
- Contact information
- Feedback on the user guide

12.2 Maintenance and Repairs

DANGER HIGH VOLTAGE - The working DC bus is live at all times when power is on. The Main Isolator feeding the drive must be switched to the **Off** position at least 15 minutes before any work is commenced on the unit. The operator must check the bus voltage with a tested working voltage measuring instrument prior to disconnecting any connectors or opening the DC Bus terminal cover. The red LED indicator on the front of the drive which indicates that there is charge remaining in the drive is only to be used as an aid to visual troubleshooting. **It shall not be relied on as a means of safety.**

There are no user serviceable parts inside the AMD2000 drive; therefore maintenance only involves inspection of the drive its connections and enclosure. Make sure that all connections are fitted correctly and that there are no signs of damage. Check that all wires are tightly fitted to the connectors and that there are no signs of discolouration which may indicate heating. Make sure all drive covers are securely fitted and that they have no signs of damage. Make sure that the drive enclosure is free from dust or anything that may inhibit its operation. Refer to section *4 Mechanical Installation* for site requirements, tools, and installation and uninstallation information.

There are no internal adjustments inside the AMD2000. For any repairs please contact our nearest office or agent. Refer to section *12.3 Product, Sales and Service Enquiries.*

12.3 Product, Sales and Service Enquiries

If you require assistance for installation, training or other customer support issues, please contact the closest ANCA Motion Customer Service Office in your area for details.

ANCA Motion Pty. Ltd.
1 Bessemer Road
Bayswater North
VIC 3153
AUSTRALIA
Telephone: +61 3 9751 8900
Fax: +61 3 9751 8901
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Email: sales.au@ancamotion.com

ANCA Motion Taiwan
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Taichung 407
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Fax: +886 4 2359 0067
www.ancamotion.com/Contact-Us
Email: sales.tw@ancamotion.com

12.4 Feedback

This user guide is based on information available at the time of publication. Reasonable precautions have been taken in the preparation of this user guide, but the information contained herein does not purport to cover all details or variations in hardware and software configuration. Features may be described herein which are not present in all hardware and software systems. We would like to hear your feedback via our website: www.ancamotion.com/Contact-Us