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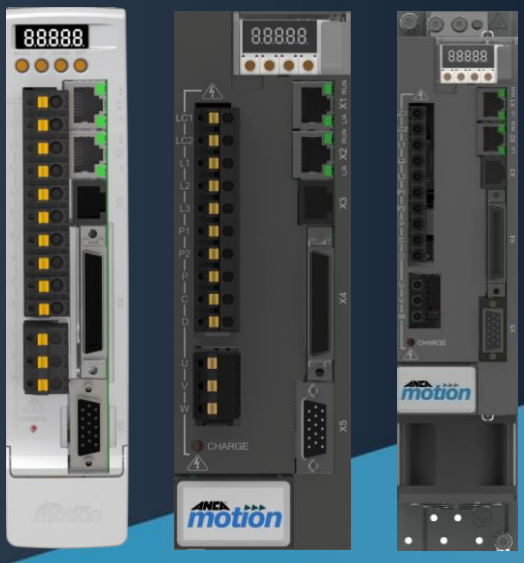
Motion Control Solutions

AMD2000 Servo Drive - User Manual

AMDOC-000754 Rev 11



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AMD2000 Servo Drive - User Manual

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	AMD Servo Drive SoE Configuration Guide
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1 Safety

Warning: To prevent possible accidents or injury, ensure you read and understand this user manual 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 manual 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 manual 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

Please read the following safety guidelines before installing the equipment:

- Equipment operators must read the User Manual carefully and make sure of the correct procedure before operating the AMD2000.
- The AMD2000 servo drive system is an Open Type product; the associated module enclosures are rated to IP20 and are classified as NEMA/UL Open Type. The drives and accessories must be mounted within an enclosure which provides access protection. Access must only be possible with the use of a tool or after de-energization of the live parts.
- 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.
- 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 manual.
- 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 section *4.4.1*). 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 or replace this equipment.
- Ensure all external wiring is clearly labelled to ensure hazardous voltages are easily identified.
- Isolate all energy sources prior to cleaning or routine maintenance.
- Use cables equal or greater cross-sectional area than the minimum recommended.
- 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 Chapter *8 Installation Checklist* and Chapter *9 Start-up* for additional checks that should be made to start up the AMD2000 Series drive safely.

2 Introduction

2.1 Purpose

This user manual 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 manual does not cover configuration of the drive. Please refer to *AMD Servo Drive SoE Configuration Guide*, for information on parameter configuration and tuning for your application.

2.2 About the AMD2000 Series Servo Drives

The AMD2000 Series 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.

In this User Manual where the term 'STO drive variants' or 'STO drives' is used, it refers specifically to the D2103 and D2109 drives only. Where the term 'AMD2000 drives' is used, it refers to the D2103, D2109 and D2015 drives.

Both the D2103 and D2109 drives covered by this user manual 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. The D2015 drive does not have this capability and should not be used in place of a STO certified drive.

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 section *3.2* for more details of the features available.

2.3 Drive Model Applicability

This user manual is applicable to the AMD2000 Series drive variants specified in *Table 2-1*.

Product	*Product Variant*	*Product Number*
AMD2000 Series Servo Drive	3 Arms with STO	D2103
	9 Arms with STO	D2109
	15 Arms non-STO	D2015

Table 2-1 Applicable Drive Variants

2.4 Terms and Abbreviations

A / mA	Ampere / milliamp
AC / DC	Alternating Current / Direct Current
AIN	Analogue Input
AMSL	Above Mean Sea Level
AOUT	Analogue Output
CNC	Computer Numerical Control
DCM	Drive-Controlled Moves
DI	Digital Input
DIP	Dual In-line Package
DO	Digital Output
DSD	Digital Servo Drive
EMC	Electromagnetic Compatibility
GND	Ground
Hz	Hertz
I/O	Input / Output
IEC	International Electrotechnical Commission
ms	Millisecond
O	Output
PE	Protective Earth
PMAC	Permanent Magnet Alternating Current
PMSM	Permanent Magnet Servo Motor
PTC	Positive Temperature Coefficient
rms	root mean square
SoE	Servo Profile Over EtherCAT® (IEC 61800-7-204)
STO	Safe Torque Off
V / mV	Volt / millivolt
W.R.T.	With Respect To
Φ	Phase
Ø	Diameter
Ω	Ohms

Table 2-2 Terms and Abbreviations

2.5 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 the reader to the AMD2000 Series Servo Drive features and functionality:

- Product features
- Functional diagram
- Drive variants
- Interpreting the product label and catalogue number
- System overview
- Front panel and connector overview

3.2 Features

The AMD2000 Series are versatile brushless AC servo drives 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, 9A or 15A.
- Direct connection to 100 Vac ~ 240 Vac 1-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) available on 3A and 9A models.
- EtherCAT® connectivity.
- Easy setup using ANCA MotionBench tool.
- Small footprint. On-board 24 Vdc power supply and auxiliary I/O reduce overall system size and cost.
- Rugged and reliable design

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

3.3 Operating Principle

The simplified circuit diagram of the drive is shown in *Figure 3-1*. The AC supply voltage is converted to DC, which is then converted into the required variable frequency AC voltage signal to drive the motor.

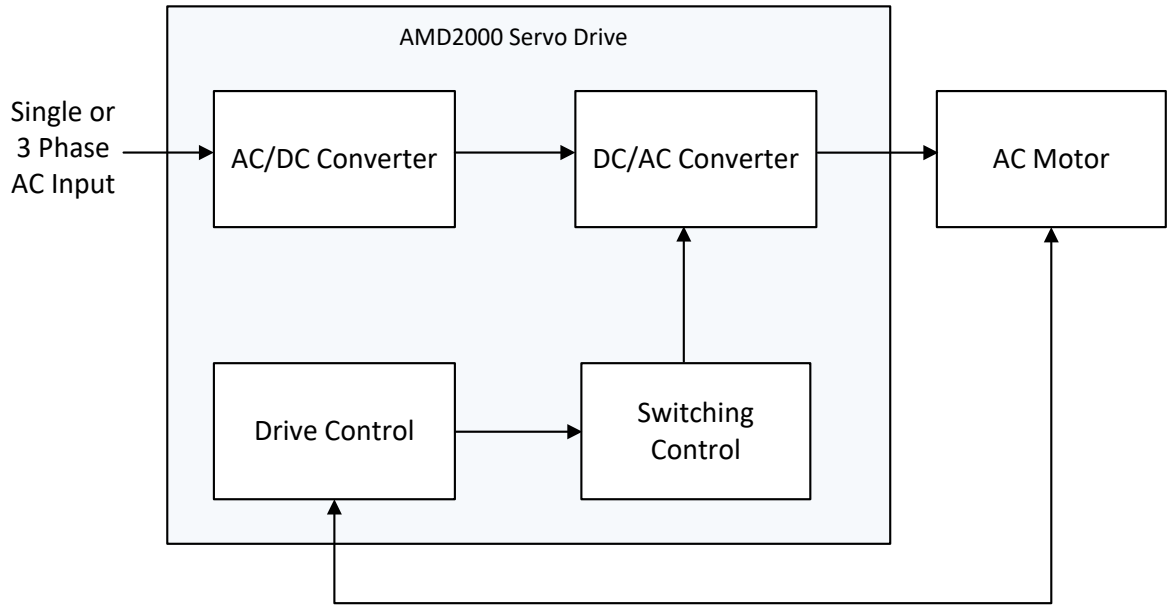


Figure 3-1 AMD2000 Servo Drive Block Diagram

3.4 AMD2000 Variant Identification

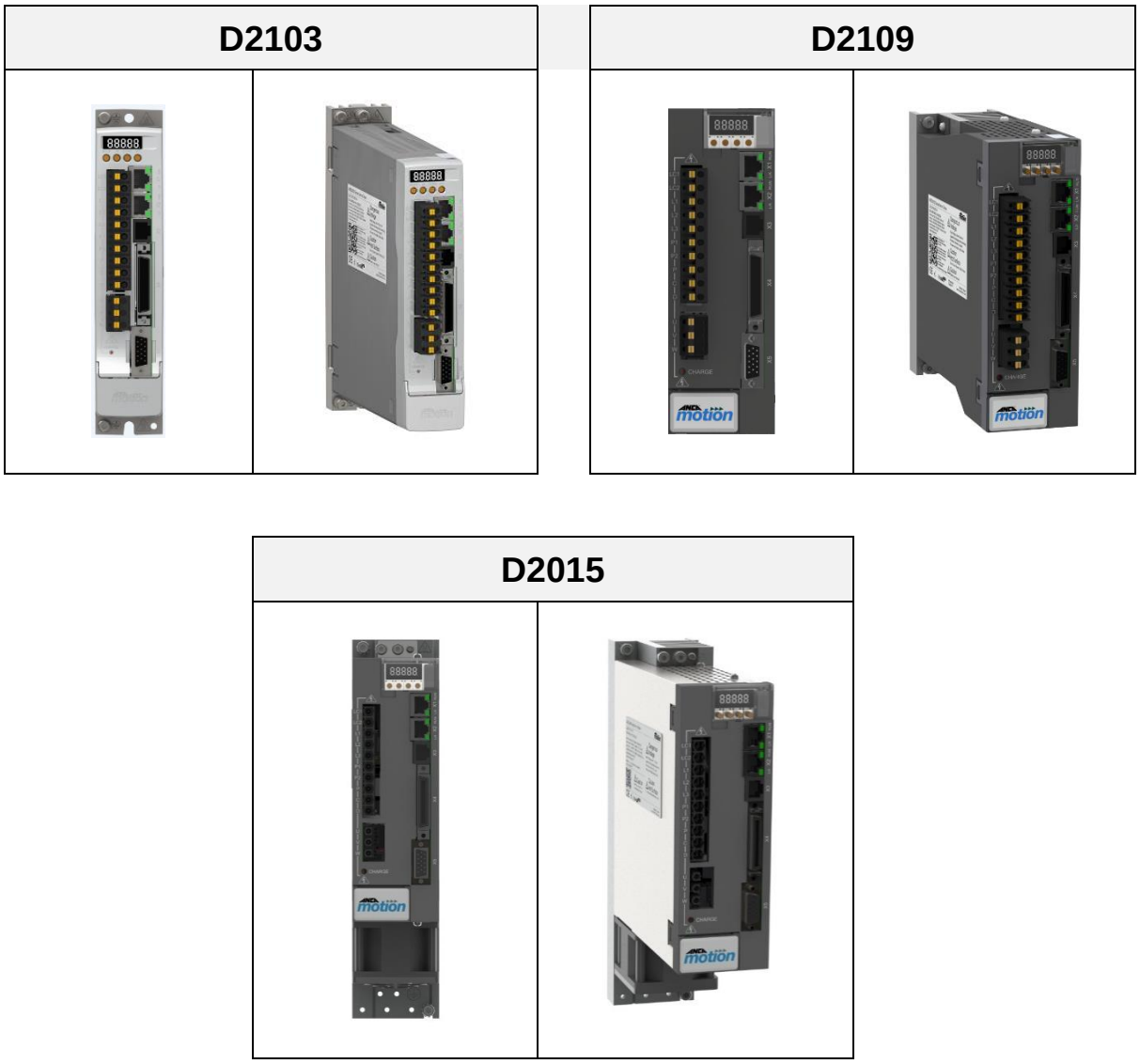


Figure 3-2 AMD2000 Series Drive Variants

3.4.1 AMD2000 Series Drive Catalogue Number Interpretation

AMD2000 drives are marked with an identification label. The Catalogue number is explained in *Figure 3-3.*

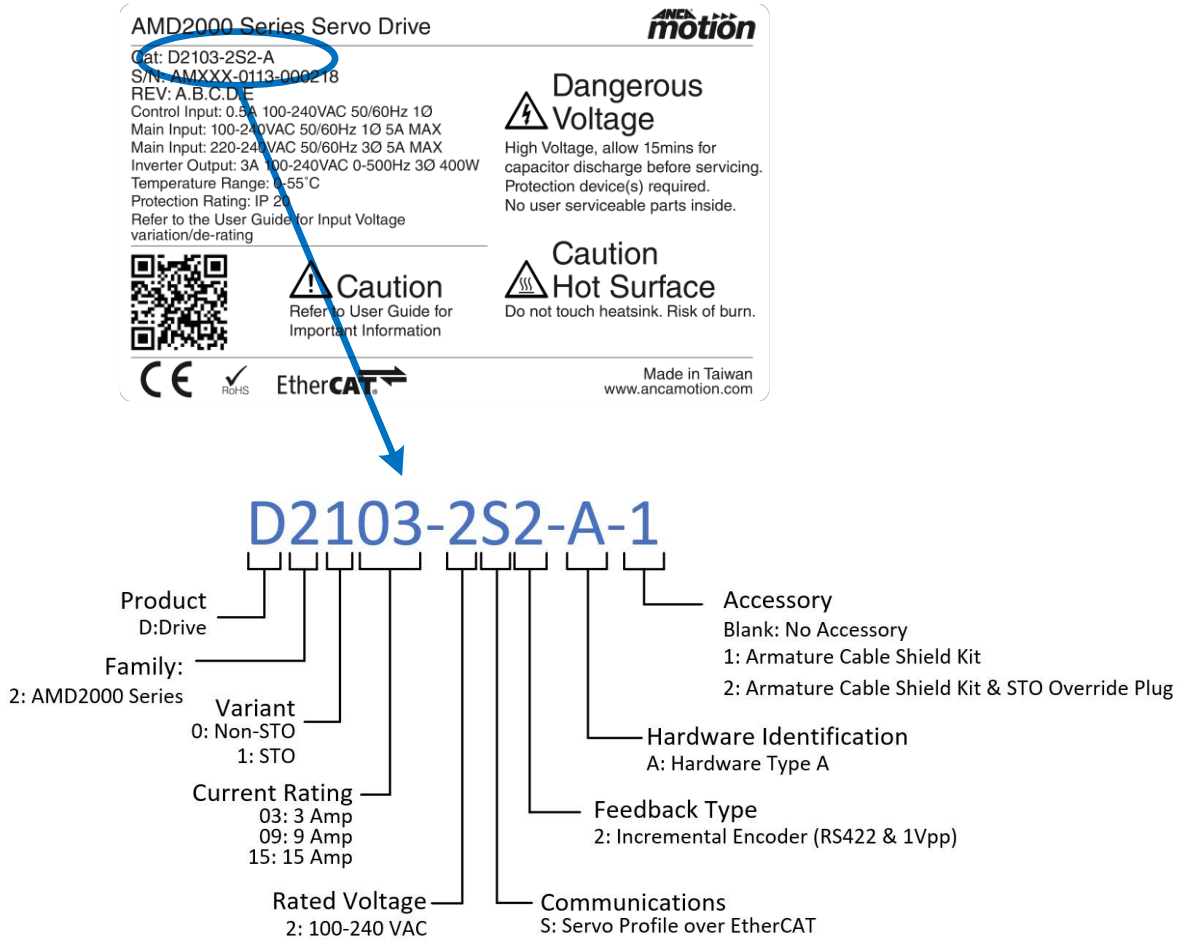


Figure 3-3 AMD2000 Series Drive Catalogue Number

Note, the above product label is generic, and each model may have different compliance marks.

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 *Figure 3-4*.

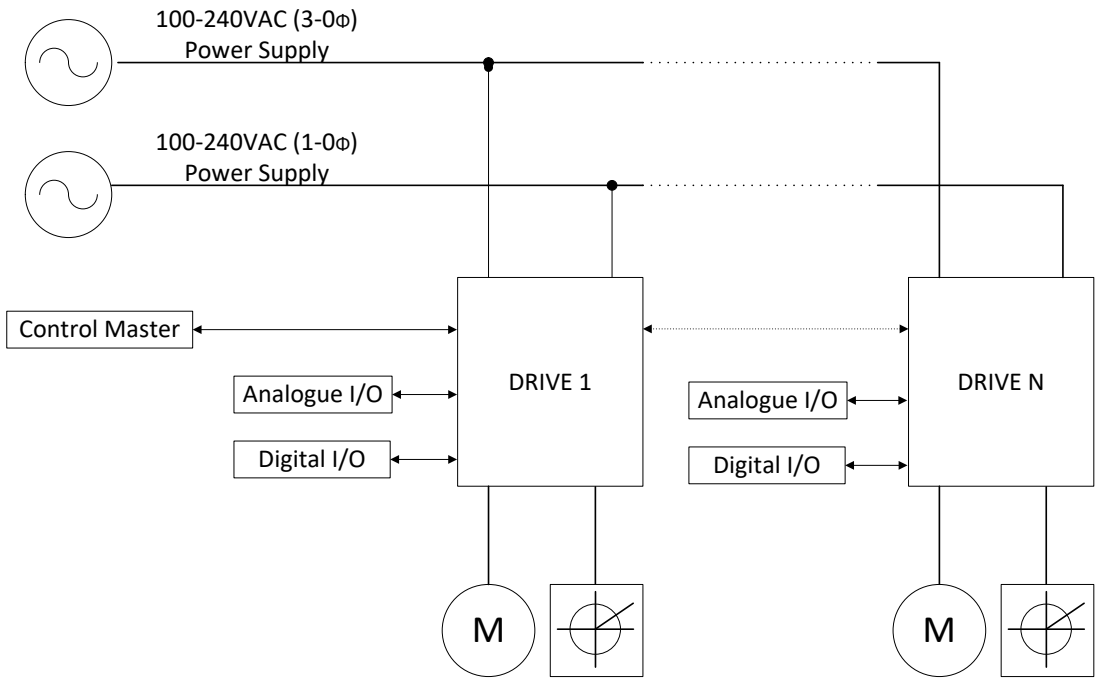


Figure 3-4 System Overview

Above example is of a drive system is supplied from a 1-phase or 3-phase mains connection with a nominal voltage of 240 Vac. 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.

Figure 3-5 shows a block diagram of the drive system. There are three versions of drive system available corresponding to maximum continuous motor current ratings of 3A, 9A and 15A. The EtherCAT communications channel is routed between the components within the drive system and the external control system via CAT5E or CAT6 shielded Ethernet cabling. This communications channel provides interconnectivity for transmitting and receiving data, such as position commands.

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

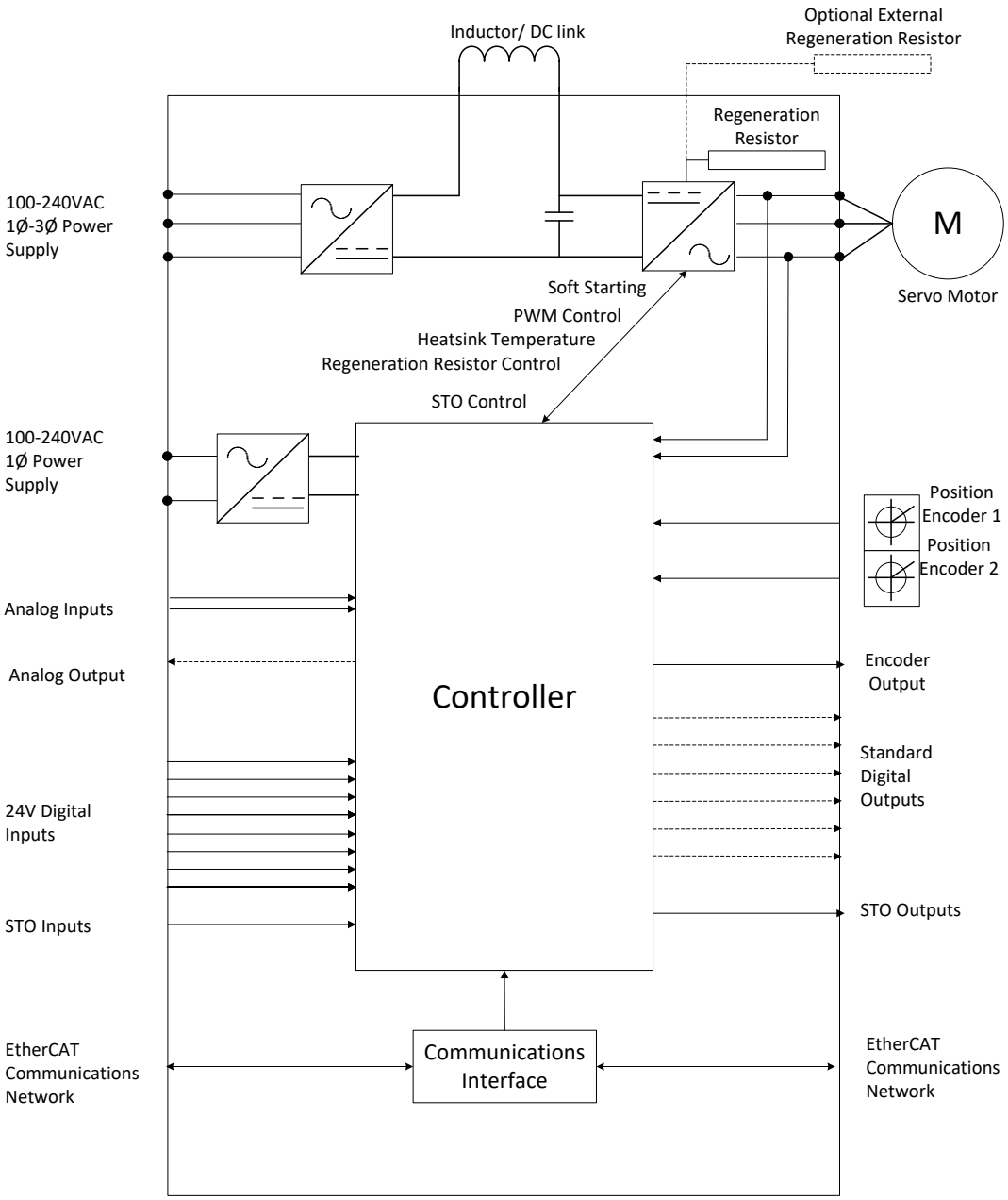


Figure 3-5 Block Diagram of the Drive System

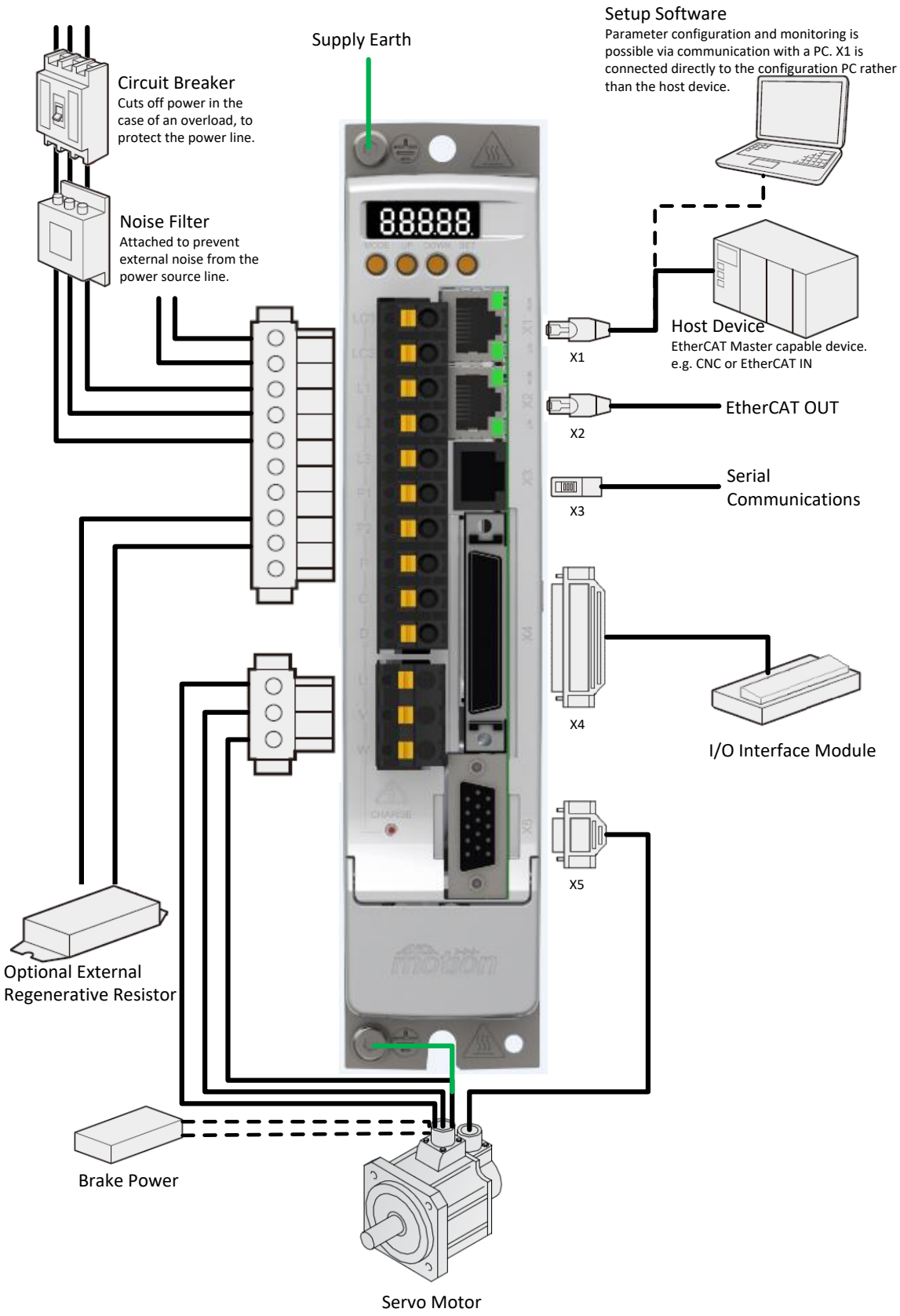


Figure 3-6 Connection Overview

3.6 Front Panel Overview

3.6.1 D2103 3A Servo Drive

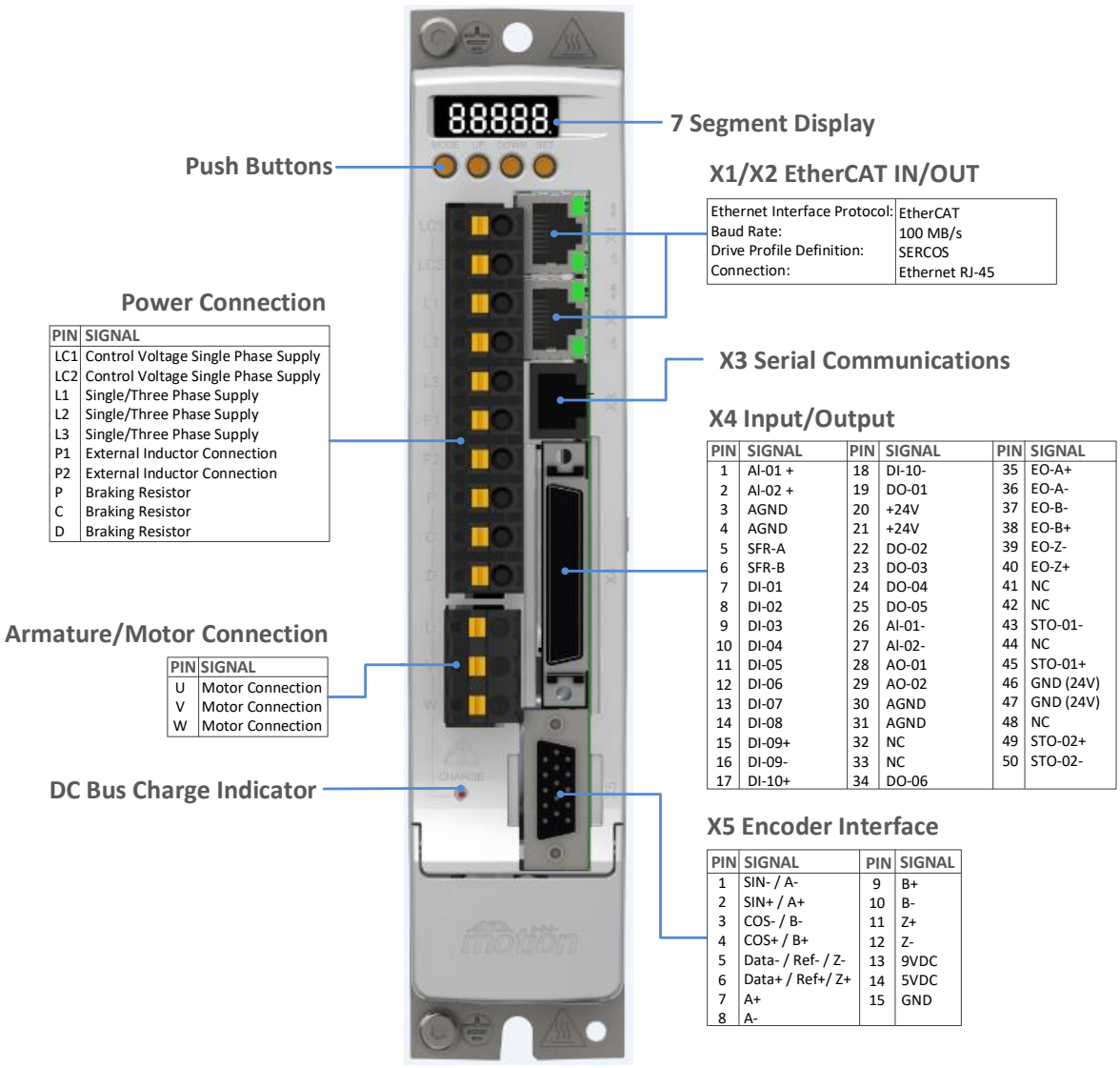


Figure 3-7 Connector Summary D2103 Servo Drive

3.6.2 D2109 9A and D2015 15A Servo Drives

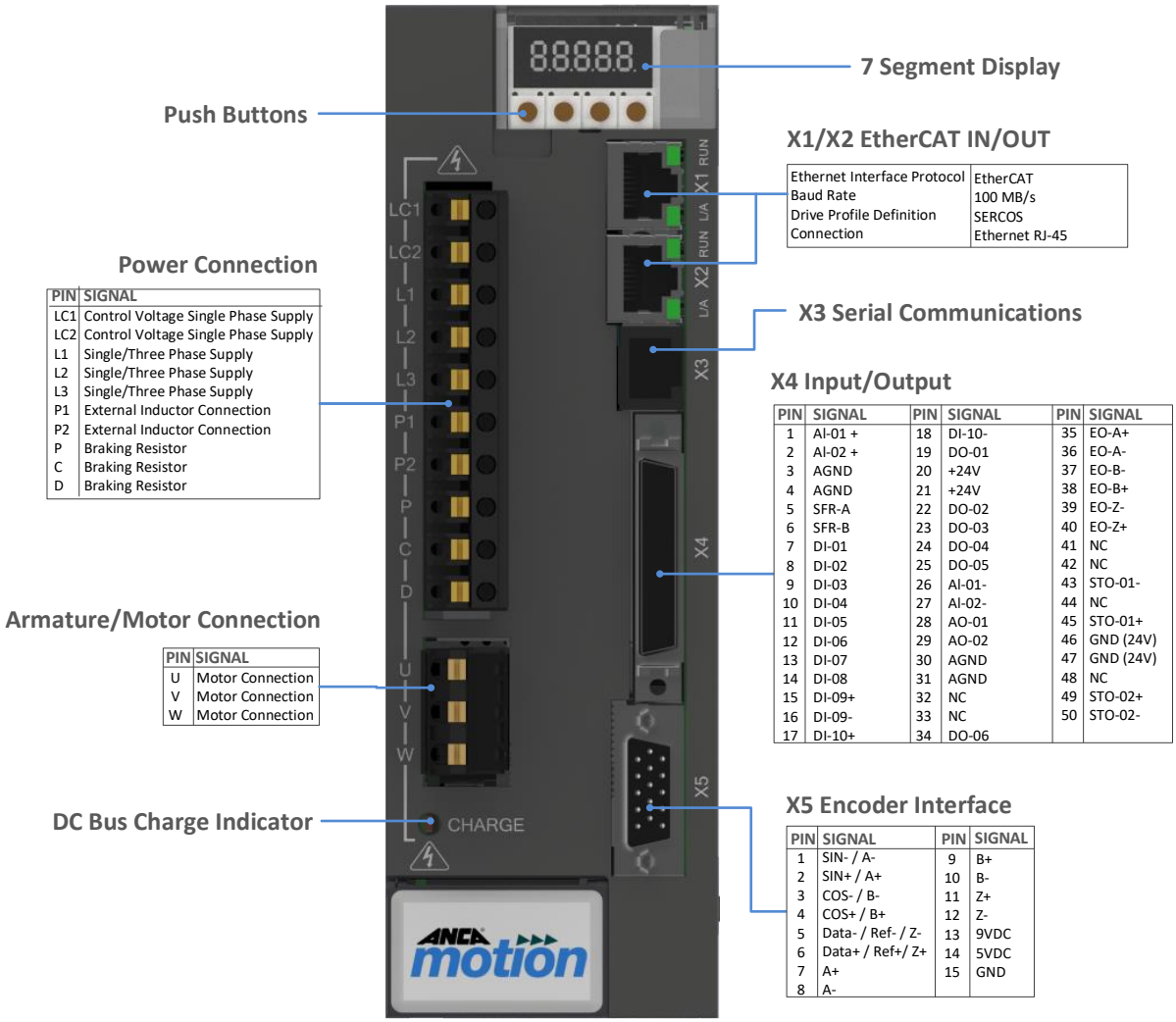
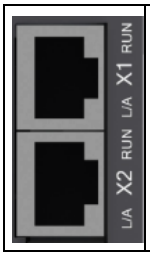


Figure 3-8 Connector Summary D2109 and D2015[1] Servo Drives

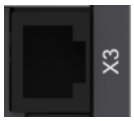
3.6.3 X1/X2 EtherCAT Connectors

	X1	EtherCAT IN
	X2	EtherCAT OUT

A mating connector or cable assembly is **not** supplied with the drive and must be ordered additionally. Refer to section *11.4.9* for EtherCAT cable ordering information.

[1] STO functionality is not supported on D2015

3.6.4 X3 Factory Use Only

	X3	Port X3 is not available for end users.

3.6.5 X4 Input / Output Connector

	X4	Port X4 is for analogue I/O, digital I/O and STO.

A mating connector or cable assembly is **not** supplied with the drive and must be ordered additionally.
Refer to section *11.4.1* for a I/O interface cable assembly.
Refer to section *11.4.4* for a 50-way mating connector.

3.6.6 X5 Encoder Interface Connector

	X5	Port X5 is for encoder connections.

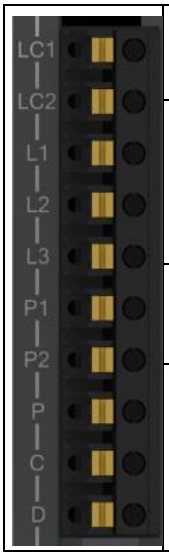
A mating connector or cable assembly is **not** supplied with the drive and must be ordered additionally.
Mating connector: high-density D-sub 15-way female with 4-40 UNC jack screws.
Refer to section *11.3* for a range of suitable encoder cable assemblies.

3.6.7 Motor Armature Cable Connector

	U V W	Motor armature cable connection

Mating connector: plug-in terminal block, male, 3-position, 7.62mm pitch (supplied with the drive).
A motor armature cable is **not** supplied with the drive and must be ordered additionally.
Refer to section *11.3* for a range of suitable motor armature cable assemblies.

3.6.8 Power, Inductor and Brake Resistor Connector



LC1 LC2	1-phase supply for control power
L1 L2 L3	1-phase or 3-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

Mating connector: plug-in terminal block, female, 10-position, 7.62 mm pitch (supplied with the drive).

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.

Refer to section *6.14* for additional information.

3.6.9 LED Display and Control Panel

The AMD2000 Series drives are fitted with a 7-segment LED display and control panel consisting of four DIP push-buttons, as shown in *Figure 3-9*.

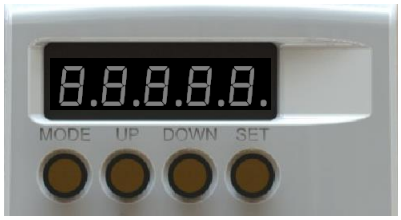


Figure 3-9 LED Display and Control Panel

The LED Display provides diagnostic information, see section *7.10.5*.
Functionality of the control panel is detailed in *Table 3-1*.

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

Table 3-1 DIP Buttons

Additional functionality may be available on custom models, refer to *AMD Servo Drive SoE Configuration Guide*.

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 requirements
- Mechanical installation instructions

4.2 Pre-Installation Checks

- Prior to installing the drive into the electrical cabinet, check the information on the identification label located on the side of the drive (see *Figure 3-3*).
- Check that drive was not damaged during transport. If there are signs of damage the drive may not be safe to use. Please notify the shipper immediately of the damage and DO NOT install the drive into the electrical cabinet.
- Check the installation tools specified in section *4.3.1* are available.
- The installer MUST read and understand:
  - the Safety Instructions in Chapter *1*
  - the Installation Requirements in Chapter *4.3*
  - the Installation Instructions in Chapter *4.4*
  - the following important warnings

Warning: The AMD2000 Servo Drive MUST be installed by trained, qualified personnel.

Warning: Prior to installing the drive, a safety risk assessment of the job and site MUST be performed and appropriate controls MUST be used to protect personel from injury and protect the drive from damage. The safety warnings and instructions detailed in Chapter *1 Safety* MUST be read, understood and followed when installing and operating the AMD2000 Servo Drive.

Warning: Electrostatic discharge (ESD) can damage electrical equipment. When handling the drive during installation or removal, protect the drive from ESD by wearing an earthed armband, or discharge yourself by touching an earthed, conductive surface before touching the drive.

4.3 Installation Requirements

4.3.1 Tools Required

To mount the AMD2000 drive, the following tools are required as a minimum:

- 4 mm Hex key with ball end for the M5x0.8P.
- 3 mm Hex Key with ball end for the M4x0.7P.
- All mounting screws to be grade 8.8 minimum (high tensile grade screws). A set of mounting screws is supplied with the drive. See section *4.4.2* for the torque specification.
- A small, flat-blade screwdriver for Encoder Connector X5 (15-way D-sub) and I/O Connector X4 (50-way Centronics).
- When ANCA Motion cables are not used, connectors MUST be assembled using only the crimp tool specified by the connector manufacturer.

4.3.2 Site Requirements

This list of installation-site requirements for the AMD2000 Servo Drive MUST be followed and adhered to. Failure to follow these site and environmental requirements may result in degraded operation, drive failure, or may void the warranty.

- The drive MUST be permanently fixed in an enclosed electrical cabinet.
- The drive MUST not be mounted in an environment containing explosive, flammable or corrosive gas or liquid, metal particles, dust or high humidity.
- The drive MUST not be mounted in an environment subject to high level electromagnetic radiation or large magnetic fields. Ensure there is sufficient distance or shielding to protect the drive from the effect of interference from adjacent equipment.
- The drive MUST be mounted in a controlled environment to meet the environmental specifications in section *10.5*.
- The electrical cabinet MUST have an environmental Ingress Protection rating of IP54 or higher. Subject to the application, site and process factors, a higher level of environmental protection may be required.

4.3.3 Mounting and Cooling Requirements

- The AMD2000 drive must be installed vertically. Refer to the installation instructions in section *4.4*.
- The drive should be mounted on a galvanised steel or bare aluminium panel with a minimum thickness of 3mm.
- The drive is designed to be mounted in an electrical cabinet and the installer is responsible to provide a solid Earth connection to the Protective Earth terminal denoted with the ⏚ symbol. M4 ring terminals are used for this connection.
- If the armature cable shield requires a termination bracket to be fitted for EMC compliance, follow the cable installation instructions is section *6.8.2*.
- Adequate ventilation must be provided, and the drive must not be installed in the vicinity of other heat generating equipment.
- The D2103 drive is designed to operate with no additional cooling. Do not use water cooling plates as this can produce condensation.
- The D2109 and D2015 drives incorporate an internal fan to cool the heatsink. These drives require forced air flow to meet performance specifications across the specified operating temperature range.
- The D2109 and D2015 drives monitor the fan rotation and report a fan failure error if the fan does not move when commanded. The drive temperature is also monitored, and a fan failure will trigger a high-temperature error and stop the drive providing energy to the motor. The fan operation and airflow should be checked when a over-temperature error occurs.
- If the required cooling and air flow requirements are not met, performance of the AMD2000 drive will deteriorate and the product lifetime will be reduced.

- The drives must be mounted with sufficient clearance inside the cabinet to ensure adequate airflow and effective cooling. The minimum clearance is specified in *Table 4-1*, *Figure 4-1* and

  Figure 4-2. These minimum dimensions MUST be followed to ensure an over-temperature error does not occur.

Drive Model	*Vertical Clearance Above/Below Drive*	*Horizontal Clearance to Cabinet Walls*	*Clearance between Adjacent Drives*
D2103 3A Drive	50 mm	15 mm	30 mm
D2109 9A Drive	50 mm	8 mm	15 mm
D2015 15A Drive	50 mm	8 mm	28 mm

Table 4-1 Mounting Clearances Requirements

Refer to section *10.5* for more information about environmental requirements and specifications.

Warning: During normal operation with a high load, the regeneration resistor and heat sink surfaces can reach temperatures above 90°C. Care must be taken to avoid burns or injury.

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

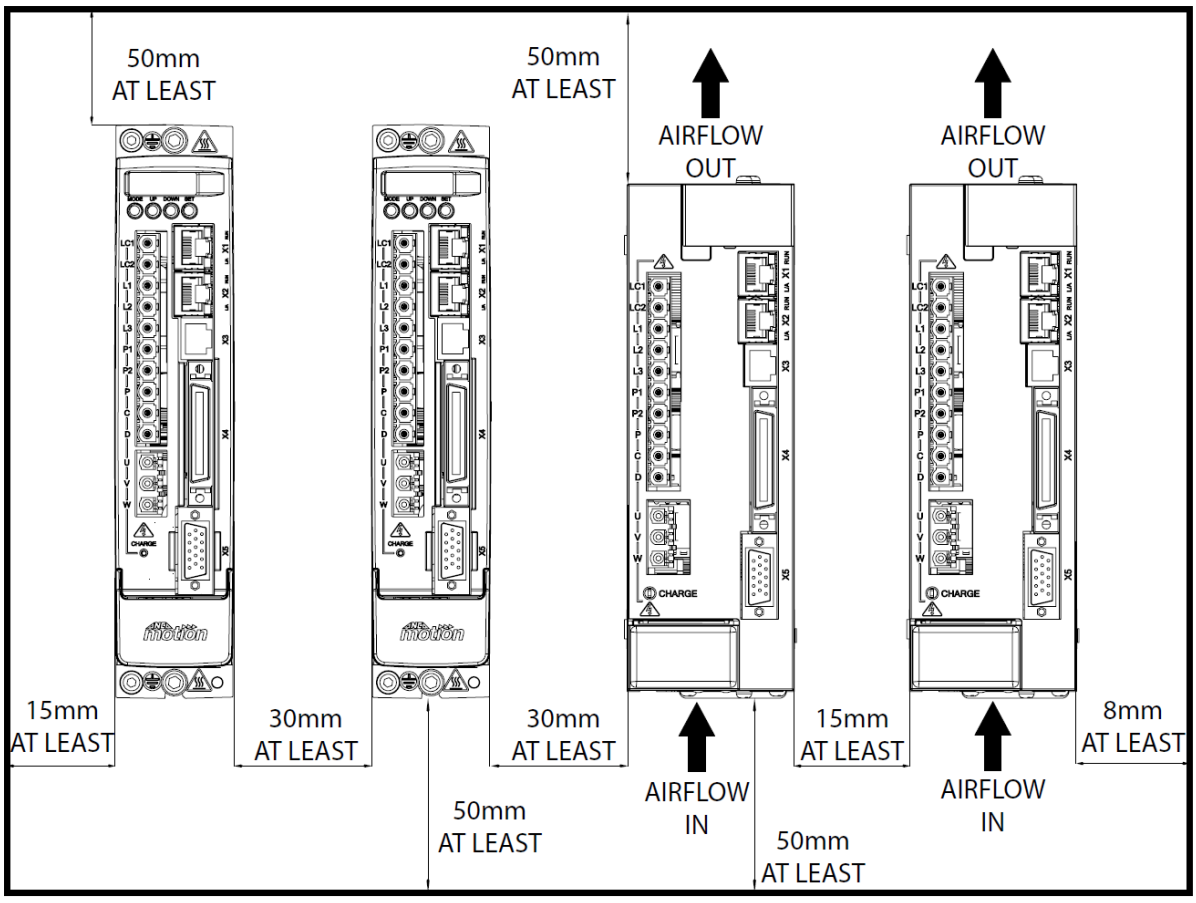


Figure 4-1 D2103 and D2109 Mounting Clearance Requirements

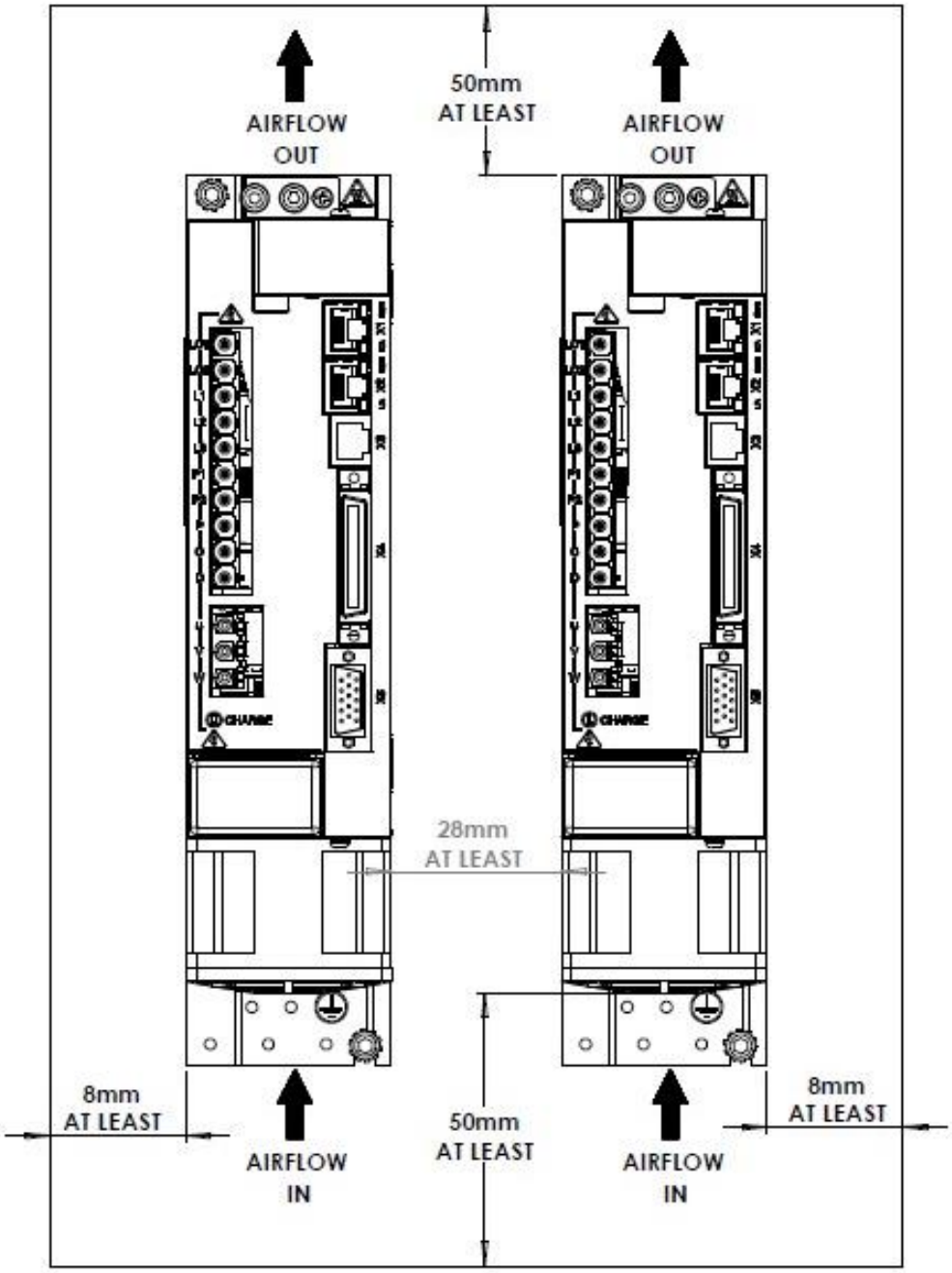


Figure 4-2 D2015 Mounting Clearance Requirements

4.4 Installation Instructions

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 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 any 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 section *6.7* 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

Mounting the AMD2000 Servo Drive is a simple 5 step process, as shown in *Figure 4-3* (D2103), *Figure 4-4* (D2109) and *Figure 4-5* (D2015),

Dimension drawings are provided in section *10.7*, which detail the drive dimensions and mounting hole positions.

STEP 1

Drill and tap 2 x M5x0.8P holes to suit the hole pattern described in section *10.7*. Note, the minimum thickness for the sheet metal panel is 3mm.

STEP 2

Fit one of the M5 mounting screws partially into the lower drilled and tapped hole so that most 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.

STEP5

Connect the appropriate electrical cables according to Chapter *5 Planning the Electrical Installation* and Chapter *6 Power Wiring*.

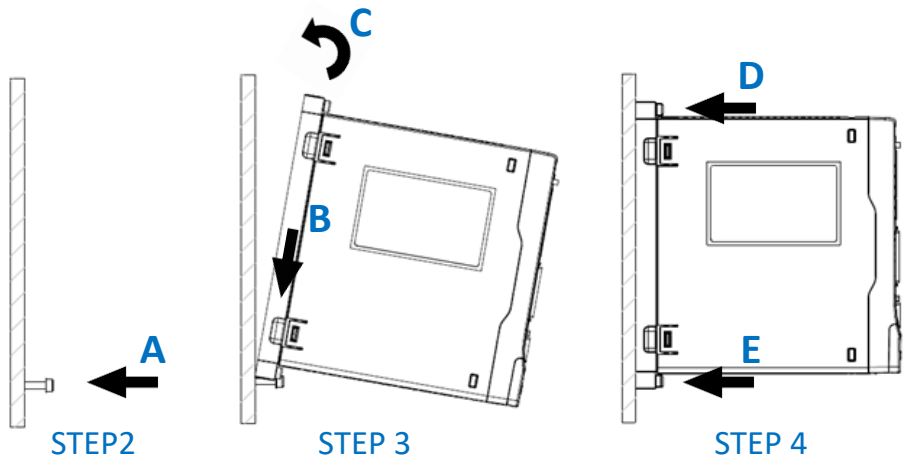


Figure 4-3 Mechanical Mounting of D2103 Servo Drive

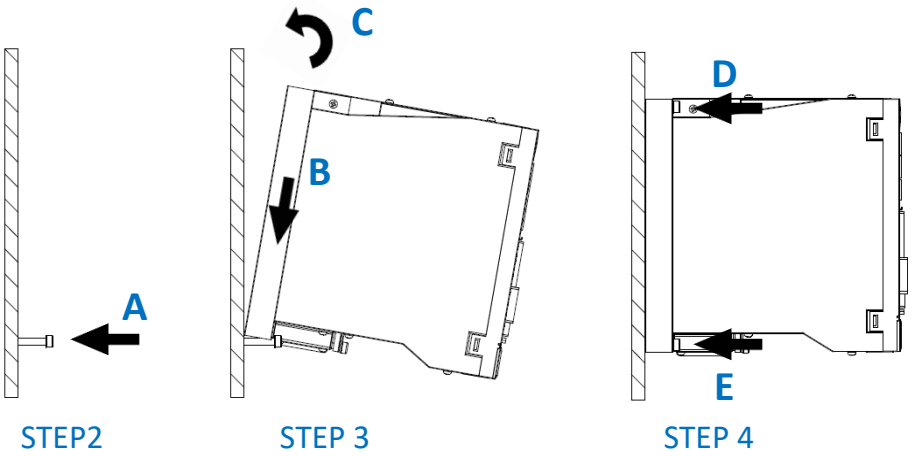


Figure 4-4 Mechanical Mounting of D2109 Servo Drive

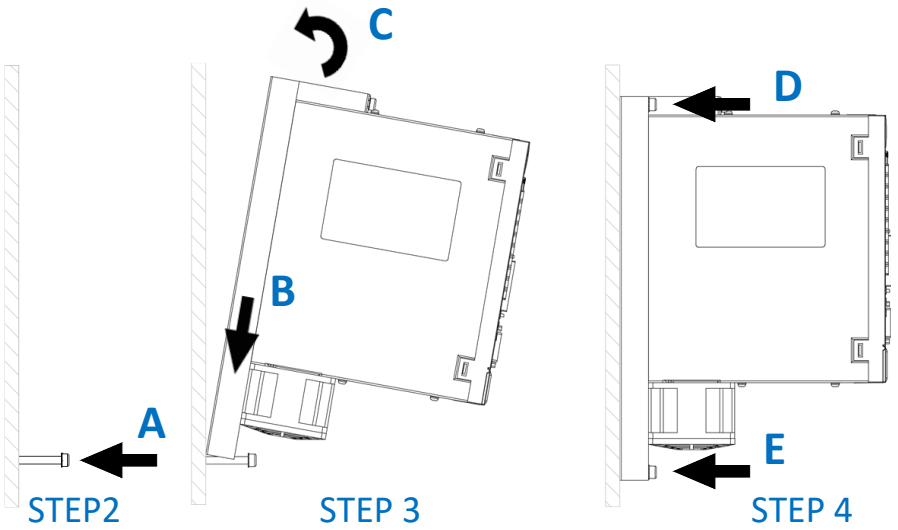


Figure 4-5 Mechanical Mounting of D2015 Servo Drive

4.4.3 Un-Mounting a Drive

STEP 1

Isolate the mains power from the drives according to section *4.4.1*.

STEP 2

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

STEP 3

Follow steps 4 through to 2 of section *4.4.2* 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 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 section *10.4.2* and the specific motor catalogue or User Manual.

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 section *6.7* 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. Refer to section *7.7* for detail about the STO function.

5.5 Thermal Overload and Protection

5.5.1 Fan Operation

The D2109 and D2015 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”)
- 47.5A for the D2015 (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 and D2015 (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 *6.7* 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.

Refer to sections *6.11*, *6.12* and *6.13* 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.

Refer to sections *10.4.5* and *10.10* 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 300 Vac. 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. Refer to section *6.7* for recommended wire gauges.

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 > 0.14 mm^2 Shielded length of cable	Impedance of 120 Ω (100 Ω is 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 > 0.14 mm^2	Impedance of 120 Ω (100 Ω is also acceptable)
Power	> 0.5 mm^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	< 10 m	-

Table 5-1 Recommendations for Motor Feedback Wiring

Further information about the available motor feedback cable assemblies can be found in section *11.3*.

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.

Table 5-2 Recommendations for EtherCAT Wiring

EtherCAT cable assembly order codes can be found in Accessories section *11.4.9*.

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 temperature 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 240 V cables be routed in separate ducts. Where this is not possible, the 24 V cable should be appropriately insulated for 240 V.

5.9 EU Machinery Directive Considerations

Customer applications which use the AMD2000 STO drives must install the same electrical accessories (EMC filter, line reactor, circuit breakers and motor/encoder cables) specified in the compliance test report and User Manual, and they must be installed according to the product instructions. The customer cannot use arbitrary filers/reactors/CB's/cables without due diligence. If the customer decides to install different components to those specified, that is acceptable, **but** the machine inspector will compare the specifications of the installed components to the recommended components. To enable this part variance to be successful, the customer **must** prepare a Technical File (TF) for the change. The TF should present a comparison of the performance specifications and characteristics of the specified components to the customer selected components and explain why they would not cause a change to compliance. Also, the customer is the responsible party for the compliance of the machine to the Machinery Directives including the EMC directive.

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 conducting 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 1-phase supply (L1C/L2C), 1-phase or 3-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 are required for EMC compliance to limit electromagnetic interference (EMI) on the mains supply; see section *6.5* for the recommended parts.

The mains control supply (LC1, LC2) for the drive requires a 1-phase supply which can be either two phases from a 3-phase supply (100-240V line to line) or from a dedicated 1-phase supply (100-240V line to neutral).

The mains power supply (L1, L2, L3) can be either from two or three phases of a 3-phase supply (100-240V line to line) or a 1-phase supply (100-240V line to neutral).

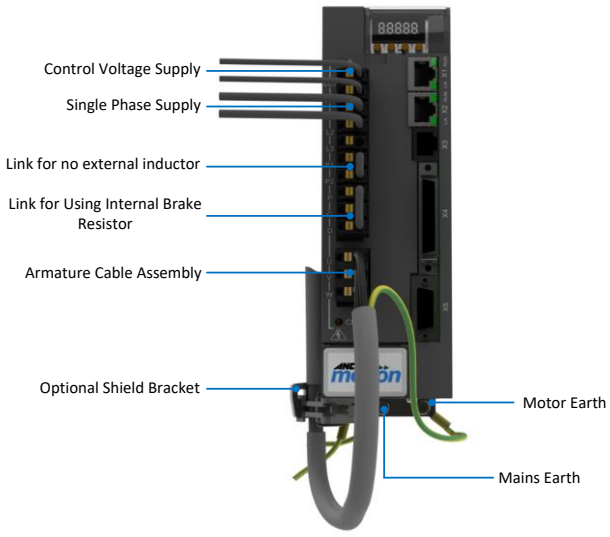


Figure 6-1 Typical View of Drive Connected for 1-phase Operation

The mains control supply can be linked to the mains power supply allowing power to be applied at the same time. The recommended multi-strand wire for power connector links (mains power supply, internal brake resistor, and external inductor) is listed in *Table 6-1*.

Drive	*Wire Dimensions*	
3A	14AWG	2.5 mm^2
9A		
15A		

Table 6-1 Typical Specification for Connector Link Wire

The mains control supply cable and the mains power supply cable are terminated on the 10-way plug-in terminal block shown in *Figure 6-2*.

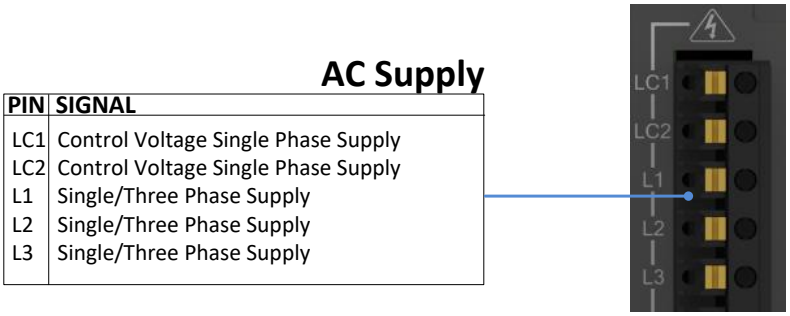


Figure 6-2 Mains Control Supply and Mains Power Supply Connector

This cage clamp style (push in spring type) mains power connector must be used with stranded wire without the use of ferrules. The recommended strip length is 10mm and the acceptable lead dress is shown in *Figure 6-3*.

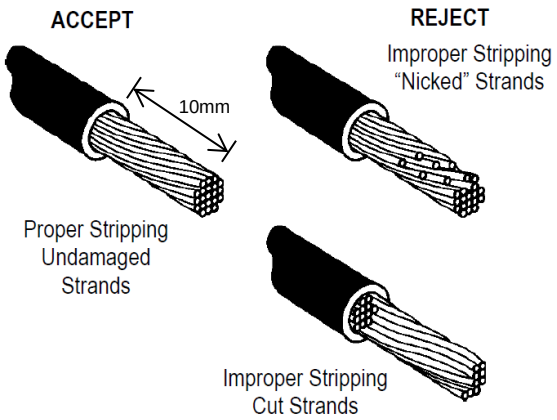


Figure 6-3 Wire Stripping

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.

Warning: The AMD2000 Series drive is suitable for use with a voltage supply exceeding Category III. According to IEC 61800-5-1, the AMD2000 drive may be connected permanently to the supply at its origin in a building. An outdoor machine installation closer to the primary distribution supply (overhead cables etc.) requires additional over-voltage suppression (transient voltage surge suppression) to reduce a Category IV installation to Category III.

Note: external soft start circuitry may be required in multi-drive applications (see section *6.6*).

6.3.1 AC Voltage Supply

The AC supply voltage range must be within the limits specified in *Table 6-2* and section *10.4*.

Attribute	*Symbol*	*Qualification*
Drive input 1-phase voltage range	$U_{L1\text{-}L2}$	90-264 Vac (100-240 ±10%)
Drive input 3-phase voltage range	$U_{L1\text{-}L2\text{-}L3}$	90-264 Vac (100-240 ±10%)
Maximum input voltage to Protective Earth	$U_{L1,L2,L3,\text{-}PE}$	264 Vac (240 + 10%)
Nominal Input frequency	f_{LN}	50 / 60 Hz

Table 6-2 Mains Supply Voltage Range (line-to-line)

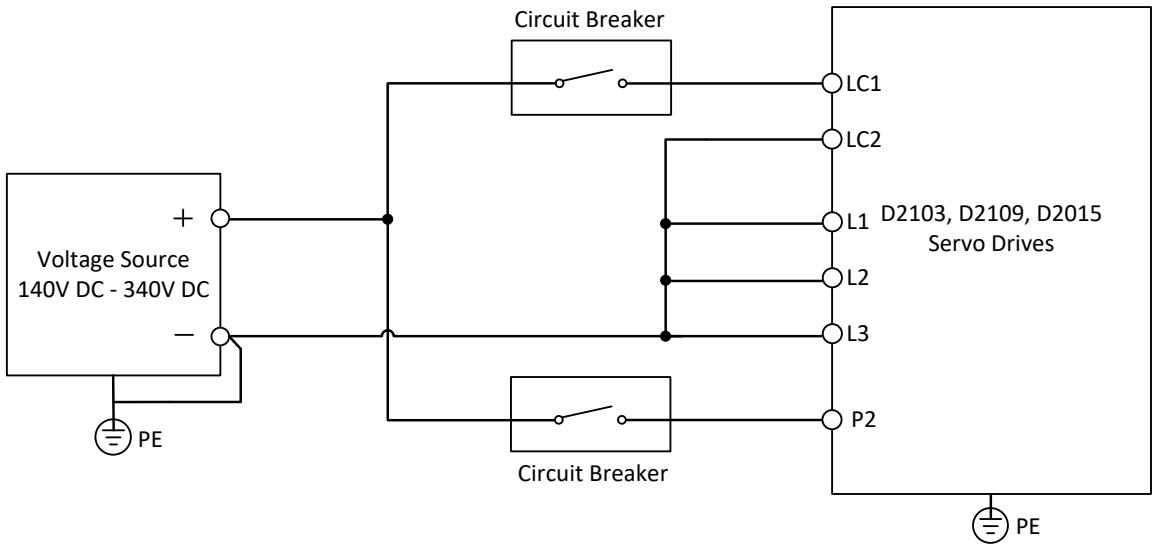
Operation at reduced supply voltage will require power de-rating as discussed in section *10.9*.

Operation using a 1-phase or 2-phase supply instead of a 3-phase supply may also require power de-rating as discussed in section *10.9*.

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 140 Vdc to 340 Vdc.

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 as a 12V battery for example, 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 3-phase supply is from a transformer with a grounded star point. Resistance grounded systems are not allowed. With TN and TT grounded 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 *6.7*. The AMD2000 drive requires appropriate circuit breakers for protection.

No separate connection for a neutral is provided, but in 1-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: The AMD2000 Series drive must not be connected to a non-grounded IT system. Proper function of the drive is reliant upon an input supply that is ground referenced.

6.3.5 Connection of Drives to Delta Transformer Systems (IT)

It is **not** recommended to connect the AMD2000 Series drive to a “Corner Earth” or “High Leg” delta transformer voltage supply because this will increase EMC interference relative to a TN or TT connected system.

Warning: The AMD2000 Series drive must not be connected to a non-grounded delta system, as it is not electrically safe. The delta tranformer output must be solidly grounded. Proper function of the drive is reliant upon an input supply that is ground referenced.

The maximum input voltage to Protective Earth must be less than 264 Vac.

6.3.6 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*. 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.

6.3.7 Residual Current-Operated Protective Device (RCD)

Residual Current-Operated Protective Devices (RCDs) provide additional protection to detect insulation faults where current is no longer contained in power conductors.

- Only 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.
- When an EMC filter is used, a delay of at least 50ms should be incorporated to prevent spurious trips.
- The leakage current is likely to exceed the trip level if all 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 are 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.

6.4.1 Protective Earth

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

Symbol for Protective Earth (PE)

6.4.2 Grounding of Individual Drives Within a Cabinet

If a single protective earth wire is used, it must have a cross sectional area of 10mm^2 or greater. If two PE wires are used, they can be the same cross-section as line conductors L1, L2, L3, due to the earth leakage current. That is, if the power conductors are 2.5mm^2, each of the two PE wires are also 2.5mm^2.

Warning: Earth leakage current in the protective earthing conductor exceeds 3.5 mA AC for all drive models D2103, D2109 and D2015.

The Protective Earth screw terminals are located on the heatsink of each drive as shown in *Figure 6-4*.

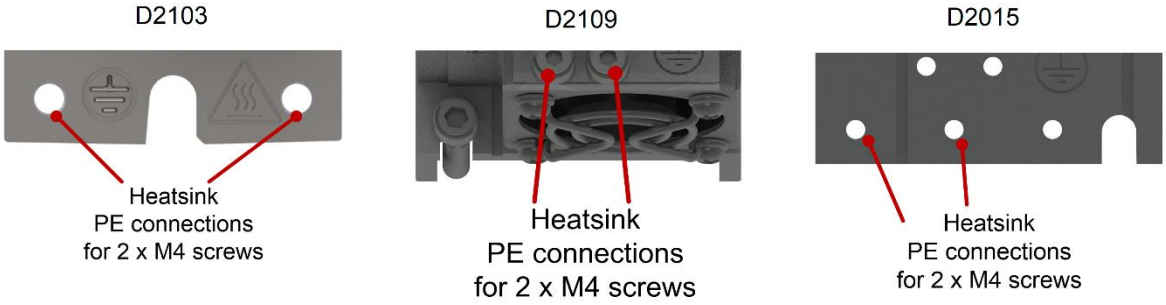


Figure 6-4 Heatsink PE Connections

The drive heatsink must be connected to the Earth Bar.

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.

6.4.3 EMI Protection - Chassis Earth and Motor Cable Bracket

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 cable shield bracket are discussed in section 6.8.2.

6.5 EMC Recommended Guidelines

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 6-5*). 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 manual. 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.

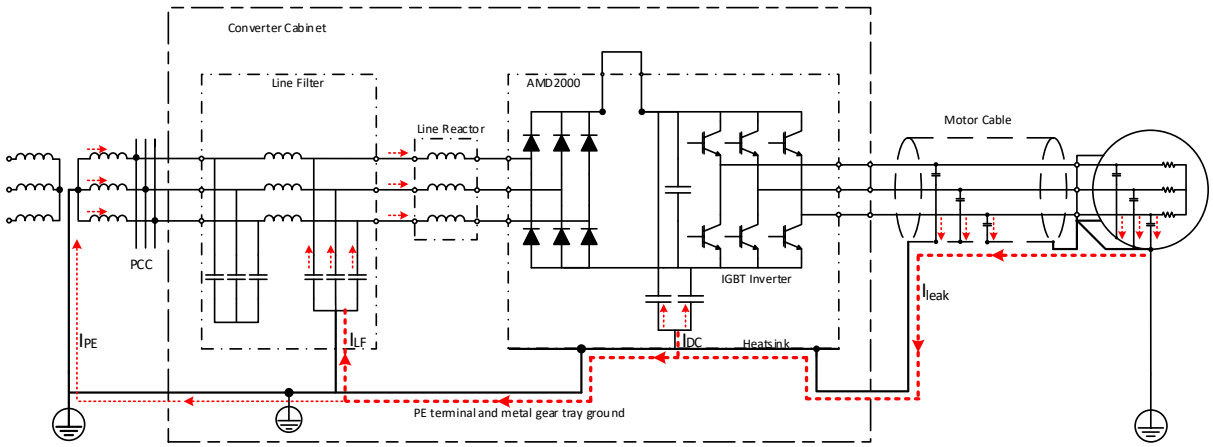


Figure 6-5 Common Mode Noise Current Paths in a Drive System

6.5.1 Recommended EMC Components for a 3-Phase Supply

Figure 6-6 and *Table 6-3* shows the EMC components recommended for wiring of a 3-phase supply system.
An EMI filter and a 3-phase line reactor are installed on the input power side.
The DC BUS side requires a link between terminals P1 and P2 with the shortest practical length of wire as specified in *Table 6-1*.

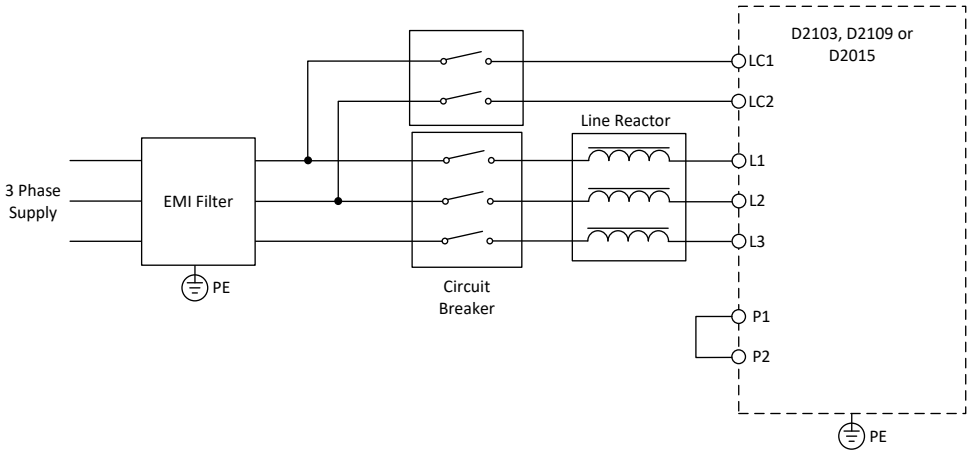


Figure 6-6 EMC Components installation for a 3-Phase Supply

Component	*Drive Type*	Rating	Recommendation (or equivalent)	
			Make	Model
EMI Filter	D2103	3-phase 10A	Schaffner	FN3270H-10-44
	D2109	3-phase 20A	Schaffner	FN3270H-20-44
	D2015	3-phase 35A	Schaffner	FN3270H-35-33
Line Reactor	D2103	3.06mH, 7.6A	Hammond Power Solutions	CRX07D6AC
	D2109	1.64mH, 14A	Hammond Power Solutions	CRX0014AC
	D2015	0.95mH 16.7A	Hammond Power Solutions	CRX16D7DC

Table 6-3 Recommended EMC Components for a 3-Phase Supply

6.5.2 Recommended EMC Components for a 1-Phase Supply

Figure 6-7 and *Table 6-4* shows the recommended EMC components for wiring of a 1-phase supply system.
An EMI filter is installed on the input power side, terminals LC1/LC2 and L1/L2.
A DC choke is installed on the DC BUS side between terminals P1 and P2.

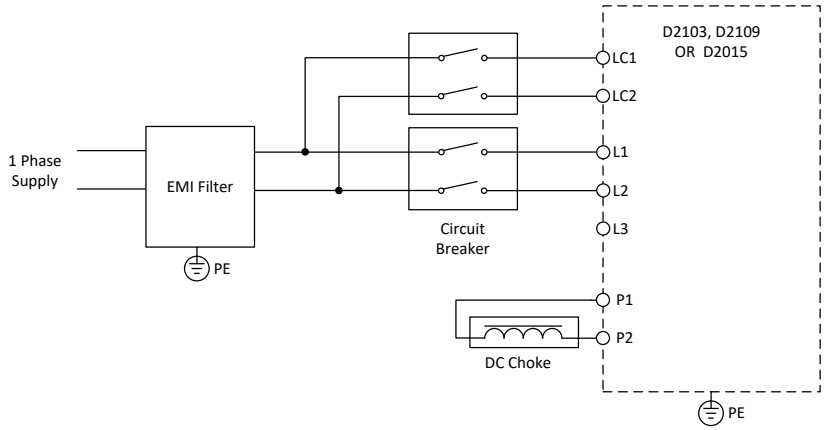


Figure 6-7 EMC Components Installation for a 1-Phase Supply

Component	*Drive Type*	*Rating*	*Recommendation (or equivalent)*	
			Make	*Model*
EMI Filter	D2103	1-phase 8A	Schaffner	FN 350-8-29
	D2109	1-phase 20A	Schaffner	FN 350-20-29
	D2015	1-phase 20A	Schaffner	FN 350-20-29
DC Choke	D2103	10mH, 5A	Hammond Power Solutions	159ZJ
	D2109	5.46mH, 14A	Hammond Power Solutions	CRX0014BC
	D2015	5.46mH, 14A	Hammond Power Solutions	CRX0014BC

Table 6-4 Recommended EMC Components for a 1-Phase Supply

Note, for 1-phase operation of the D2109 and D2015, we recommended using 3-phase line reactor CRX0014BC wired as a DC choke according to *Figure 6-8.*

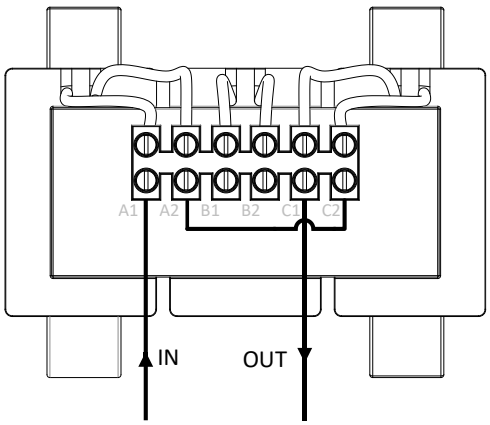


Figure 6-8 Using a 3-Phase Line Reactor as a DC Choke

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.
- EMC components MUST be mounted on a galvanised steel or bare aluminium panel to provide a low impedance return path to Protective Earth. A minimum plate thickness of 3mm is recommended for rigidity. If the EMC components are mounted on a metal gear tray, connect the tray to PE using the shortest possible, flat, braided copper 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 section *6.4*).
- Minimize motor cable length and use correctly shielded motor cables (refer to section *6.8.2*). For longer cable lengths a ferrite ring on the drive output will reduce EMC noise.

6.6 Power Supply Soft Start Module

The AMD2000 servo drives *control power supply* causes an in-rush current on start-up due to the input capacitance. For multidrive applications, the recommended circuit is one 2A breaker per drive. For applications which cannot use the recommended circuit, an optional accessory called an AMD2000 Soft Start Module can be used to control the total inrush-current to less than 2A and avoid the control circuit breaker being tripped.

Note: ANCA Motion's ***preferred*** power wiring configuration for multidrive applications is to install a separate circuit breaker for each AMD2000 servo drive. ***Only use the Soft Start Module if installing multiple circuit breakers is not viable.***

Warning: Only use the Soft Start Module with AMD2000 servo drives.

Warning: When the soft start module is used to limit the inrush current to the drive control power supply, a wait time of 2 minutes is required between a machine shutdown and reboot cycle during configuration/development. Otherwise, the 2A circuit breaker may trip on the next power on cycle.

6.6.1 Soft Start Module Wiring

The recommended wiring configuration for the optional Soft Start Module is shown in *Figure 6-9*.

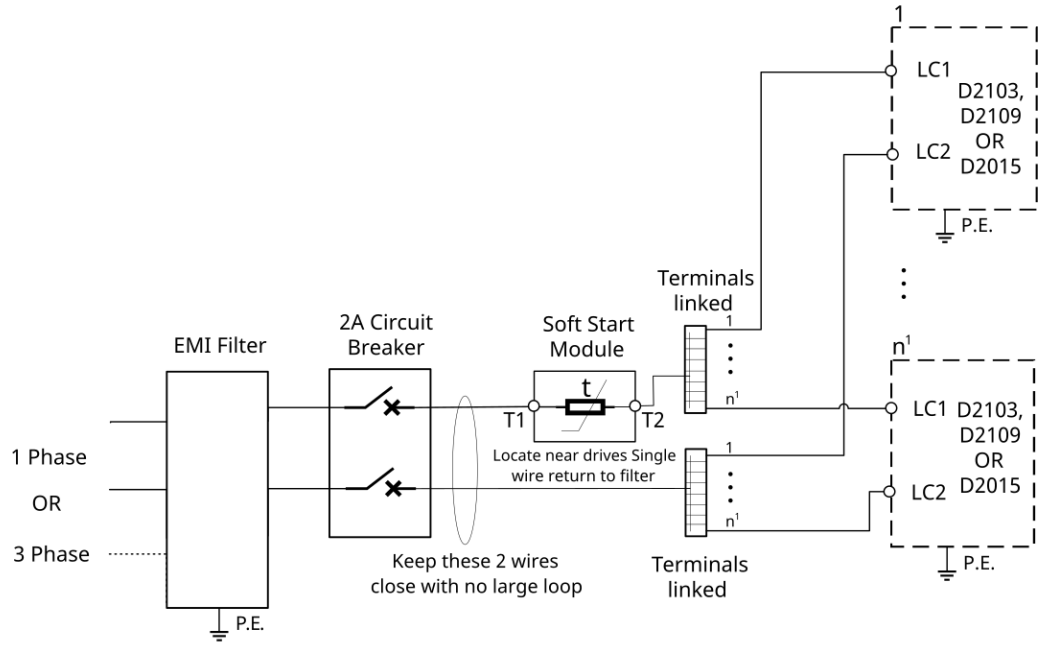


Figure 6-9 Power Supply Soft Start Module Wiring Diagram.

- The Soft Start Module wiring is identical for 1-phase and 3-phase installations, downstream of the filter.
- The Soft Start Module uses a 2 pin cage clamp connector. When wiring the plug follow the instructions for stripping and preparing the wire detailed in section *6.3*.
- Select wire gauge by referring to the minimum requirements of the 1-phase control circuitry specified in section *6.7*.
- Ensure the plug is fully inserted into the connector of the Soft Start Module before operation.

Table 6-5 details the limits when using the Soft Start Module in multi-drive configurations at mains supply voltages of 100 Vac and 240 Vac i.e. maximum number of drives, total I/O current, and total encoder current:

Power Supply Voltage	***Max. Number of Servo Drives***	***Max. Total I/O Current***	***Max. Total Encoder Current***
100 Vac +10%	4	1000 mA	800 mA
240 Vac +10%	8	2000 mA	1600 mA

Table 6-5 Drive restrictions when using the Soft Start Module.

6.6.2 Soft Start Module Installation

Figure 6-10 illustrates the mounting and installation requirements for the Soft Start Module.

- The Soft Start Module must be mounted within an enclosure which only provides access with the use of a tool or after the de-energization of live parts.
- The Soft Start Module must be mounted on 35mm TS35 DIN rail (EN 60715). Both 7.5mm and 15mm deep DIN rail are suitable.
- The DIN rail must be installed horizontally on a vertical surface to ensure airflow travels vertically through the soft start module's air vents.
- The Soft Start Module must be mounted vertically with the plug at the bottom.
- The vents on the Soft Start Module's enclosure must not obstructed (e.g. by a label)
- Provide at least 50mm clearance around all sides as shown in *Figure 6-10*.
- The Soft Start Module must not be operated above 1000m Mean Sea Level (AMSL).
- Do not install the Soft Start Module if there are any visible signs of damage to the product.

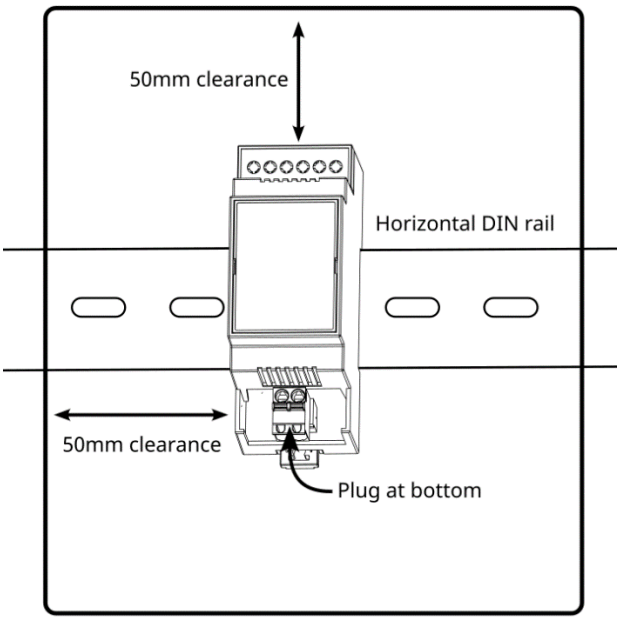


Figure 6-10 Soft Start Module Installation

- To mount the Soft Start Module on DIN rail, position the white clip (fixed) over the top edge of the DIN rail and press the module against the rail until you hear the black clip (spring-loaded) click into place. Refer to *Figure 6-11*.

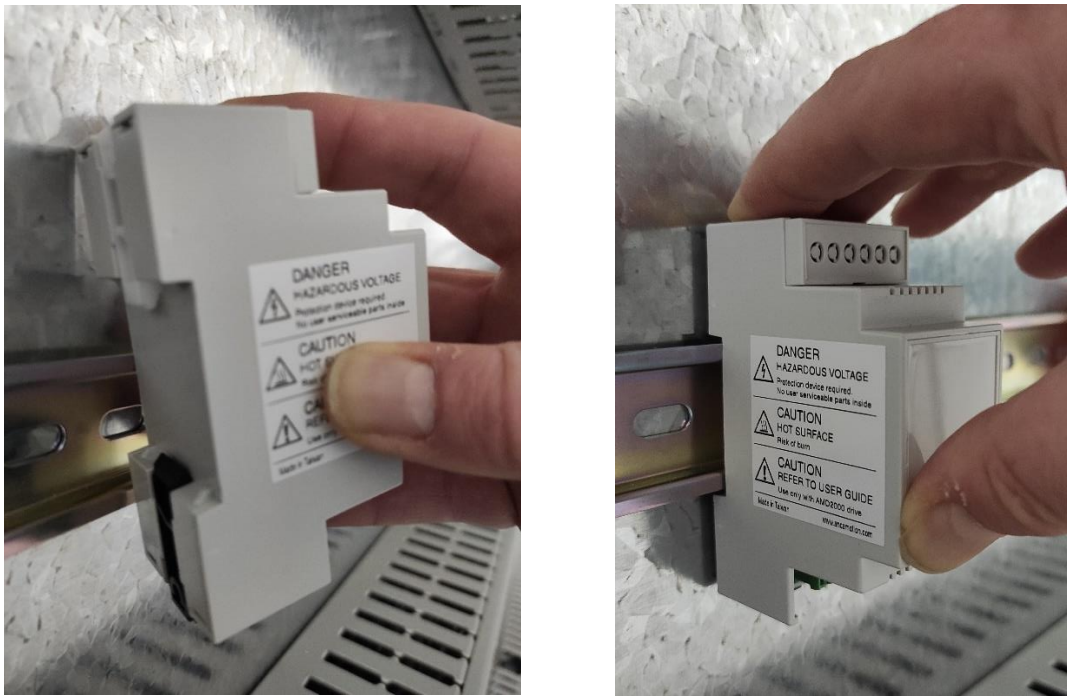


Figure 6-11 Mounting the Soft Start Module to the DIN Rail

Warning: After clipping the product to the DIN rail, ensure the module is fastened securely and the white clip is fully inserted, flush with the top surface of the housing, as shown in *Figure 6-12*.

Figure 6-12 Ensure the White Clip is Fully Inserted

- To unmount the Soft Start Module from the DIN rail, insert a flat blade screwdriver into the black, spring-loaded clip; use a small amount of downward force (as shown in *Figure 6-13*) to unclip the module from the bottom edge of the DIN rail.

Figure 6-13 Unmounting the Soft Start Module from the DIN Rail

Warning: The Soft Start Module will generate heat when in use. Incorrect installation may be hazardous.

6.6.3 Soft Start Module Maintenance

There are no user serviceable parts inside the Soft Start Module. The only maintenance involves visual inspections of the enclosure:

- At least once a year ensure the vent slots on the Soft Start Module are not blocked by external contaminants (e.g. dust). To clean the vent slots, gently use a soft-bristled brush. Do not use compressed air. Do not disassemble.
- If the Soft Start Module develops any visible signs of damage, it must be removed from service.

6.7 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 drive 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 a 3-phase supply, all phases require isolation and protection, as shown in *Figure 6-14*.

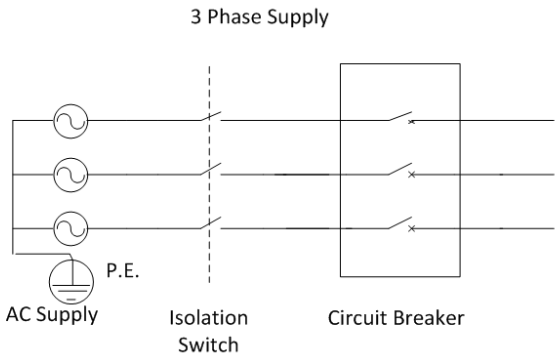


Figure 6-14 Isolation Switch and Circuit Breaker for 3-Phase Supply

When using two phases of a 3-phase supply, each phase must have suitable protection and the voltage must not exceed the rated input voltage. See *Figure 6-15*.

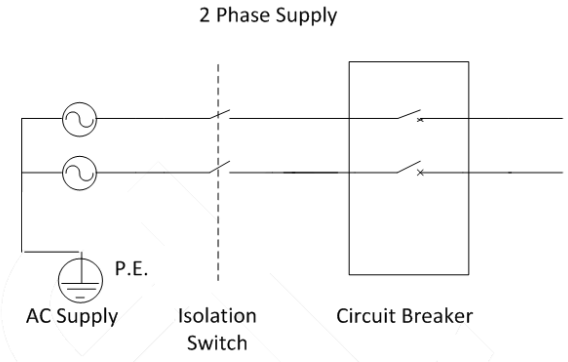


Figure 6-15 Isolation Switch and Circuit Breaker for 2-Phase Supply

When using a 1-phase supply with a Neutral conductor, protection and isolation are only required on the supply phase, as shown in *Figure 6-16*.

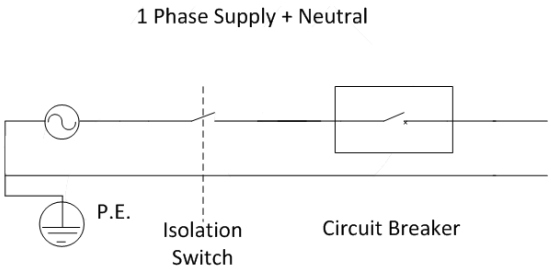


Figure 6-16 Isolation Switch and Circuit Breaker for 1-Phase Supply

The recommended circuit breaker and wire gauge for an AC and DC power source are shown in *Table 6-6* and *Table 6-7*.

Drive Type	Current Rating (nom.)	AC Supply	Input Current (max. Arms)	Circuit Breaker Rating (C-type)	Ø Wire Gauge (min.)	
					AWG	mm²
AMD2103	3 A	1Φ power	5 A	6 A	16	1.5
		3Φ power	5 A	6 A	16	1.5
		1Φ control	0.5 A	2 A	20	0.5
AMD2109	9 A	1Φ power	13 A	16 A	14	2.5
		3Φ power	13 A	16 A	14	2.5
		1Φ control	0.5 A	2 A	20	0.5
AMD2015	15 A	1Φ power	13 A	16 A	14	2.5
		3Φ power	13 A	16 A	14	2.5
		1Φ control	0.5 A	2 A	20	0.5

Table 6-6 Recommended AC Circuit Breaker and Supply Wire Size

Drive Type	Current Rating (nom.)	DC Supply	Input Current (max. Adc)	Circuit Breaker Rating (C-type)	Ø Wire Gauge (min.)	
					AWG	mm²
AMD2103	3 A	Power	3 A	4 A	16	1.5
		Control	0.5 A	1 A	20	0.5
AMD2109	9 A	1Φ power	9 A	10 A	14	2.5
		3Φ power	13.8 A	16 A	14	2.5
		1Φ control	0.5 A	2 A	20	0.5
AMD2015	15 A	1Φ power	9 A	10 A	14	2.5
		3Φ power	13.8 A	16 A	14	2.5
		1Φ control	0.5 A	2 A	20	0.5

Table 6-7 Recommended DC Circuit Breaker and Supply Wire Size

Further notes regarding the circuit breaker and power supply wire gauge:

- Power cables must conform to the local electrical installation regulations and wiring code.
- The wire gauge specified in tables 6-6 and 6-7 is based on 75 °C (167 °F) copper wire. Use of higher temperature cable may allow smaller gauge wires.
- Cable sizes are a guide only as installation methods such as grouping, length, use of conduits and ambient temperature will 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.

6.8 Motor Connections

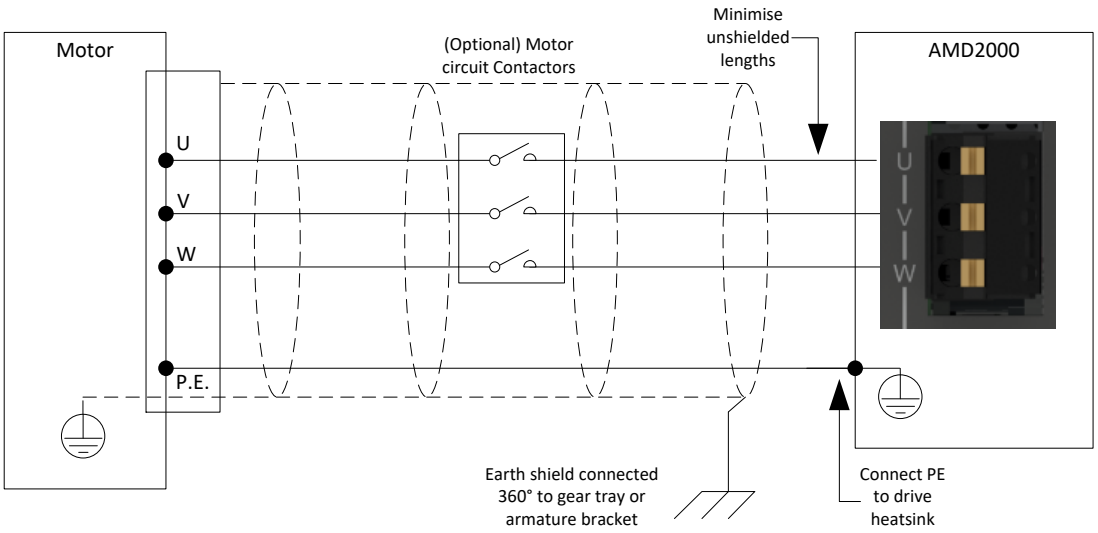


Figure 6-17 Motor Connections and Shielding

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.

6.8.1 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 continuous on both sides of the motor circuit contactor as shown in *Figure 6-17*.

6.8.2 Motor Armature Cable Shielding

To comply with the EMC requirements and minimize effects to other equipment, motor cables and power supply cables MUST include a shield. 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 the EMC filter or common-mode capacitors, as shown in *Figure 6-17*.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.

6.8.2.1 D2103 Armature Cable Shielding

Use an Armature Cable Shield Termination Bracket to terminate the shielded cable assembly. Refer to accessories section *11.4.10* for bracket ordering details.

The Armature Cable Shield Termination Bracket assembly consists of the following parts:

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

Installation instructions:

- Clamp the Armature Termination Bracket down as shown below using the 2 x M4 existing screws that came with the drive. The maximum tightening torque is 2.5 Nm.
- Carefully remove the armature cable sheath to expose the metal braid. Expose approximately 25mm of braid length. Refer to section *6.8.2.4* for details on this process and suggested tools.
- The position of the exposed braid is to coincide with the EMC Saddle Clamp and the metal bracket to provide sufficient contact for termination (see *Figure 6-18* and *Figure 6-19*).
- Tighten the Saddle Clamp screw to a maximum torque of 0.5 Nm.
- Fit the armature cable to the plugin terminal block 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 in *Figure 6-18* and *Figure 6-19*. The maximum tightening torque is 1.5 Nm.
- 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 (see *Figure 6-18*). The maximum tightening torque is 1.5 Nm.
  b) A single PE wire if the conductor size is greater than 10mm² Cu by using a single M6 screw (see *Figure 6-19*). The maximum tightening torque is 3 Nm.

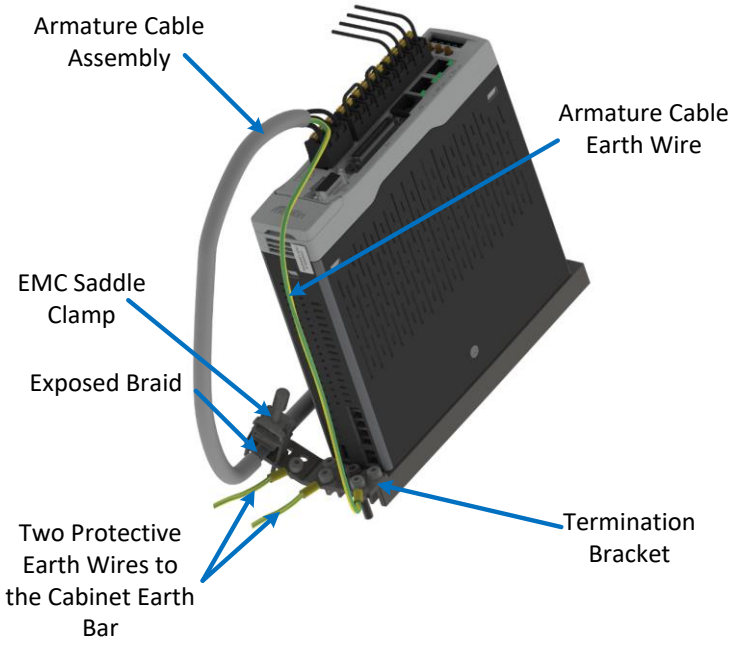


Figure 6-18 D2103 Armature Cable Shield Connection with Two PE Wires

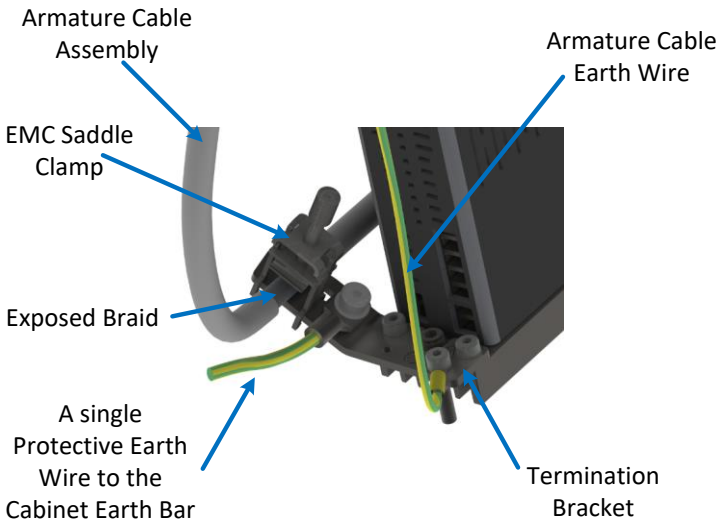


Figure 6-19 D2103 Armature Cable Shield Connection with One PE Wire

6.8.2.2 D2109 Armature Cable Shielding

Use an Armature Cable Shield Termination Bracket to terminate the shielded cable assembly. Refer to accessories section *11.4.10* for bracket ordering details.

The Armature Cable Shield Termination Bracket assembly consists of the following parts:

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

Installation instructions:

- Clamp the Armature Termination Bracket down as shown below using the 2 x M4 existing screws that came with the drive. The maximum tightening torque is 2.5 Nm.
- Carefully remove the armature cable sheath to expose the metal braid. Expose approximately 25mm of braid length. Refer to section *6.8.2.4* for details on this process and suggested tools.
- The position of the exposed braid is to coincide with the EMC Saddle Clamp and the metal bracket to provide sufficient contact for termination (see *Figure 6-20* and *Figure 6-21*).
- Tighten the Saddle Clamp screw to a maximum torque of 0.5 Nm.
- Fit the armature cable to the plugin terminal block 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 in *Figure 6-20* and *Figure 6-21*. The maximum tightening torque is 1.5 Nm.
- The Armature Termination Bracket has been designed to allow the Protective Earth (PE) wires to be connected in two ways:
    c) Connection for two PE wires less than 10mm² Cu by using two M4 screws (see *Figure 6-20*). The maximum tightening torque is 1.5 Nm.
    d) A single PE wire if the conductor size is greater than 10mm² Cu by using a single M6 screw (see *Figure 6-21*). The maximum tightening torque is 3 Nm.

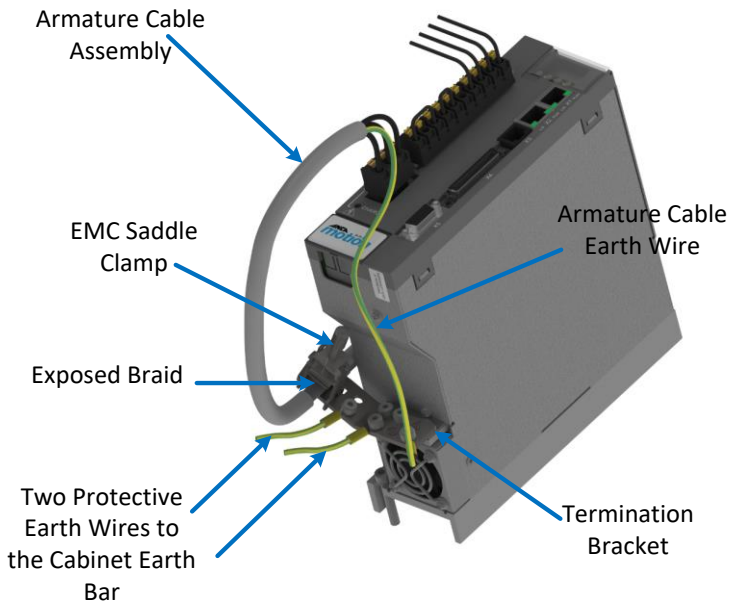


Figure 6-20 D2109 Armature Cable Shield Connection with Two PE Wires

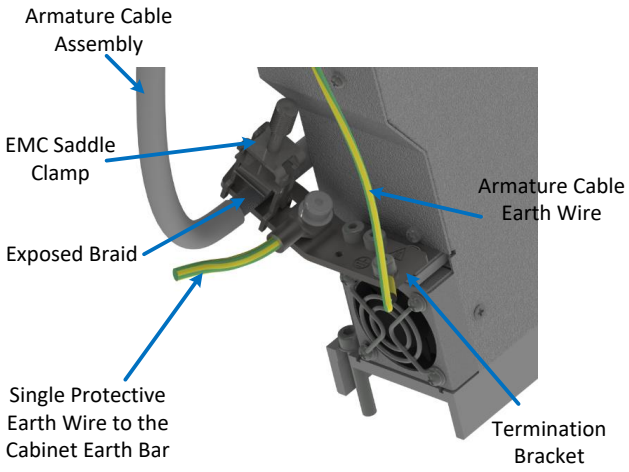


Figure 6-21 D2109 Armature Cable Shield Connection with One PE Wire

6.8.2.3 D2015 Armature Cable Shielding

Use an Armature Cable Shield Termination Bracket to terminate the shielded cable assembly. Refer to accessories section *11.4.10* for bracket ordering details.

The Armature Cable Shield Termination Bracket assembly consists of the following parts:

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

Installation instructions:

- Clamp the Armature Termination Plate down as shown below using the 2 x M4 provided. The maximum tightening torque is 2.5 Nm.
- Carefully remove the armature cable sheath to expose the metal braid. Expose approximately 25mm of braid length. Refer to section *6.8.2.4* for details on this process and suggested tools.
- The position of the exposed braid is to coincide with the EMC Saddle Clamp and the plate to provide sufficient contact for termination (see *Figure 6-22*).
- Prior to fitting the saddle clamp, install the M3 screw to the plate where shown. The maximum tightening torque is 0.7 Nm.
- Align the exposed braid to the plate and disengage the clips of the Saddle Clamp for the saddle to clamp down onto the braid.
- Fit the armature cable to the plugin terminal block on the drive.
- Ensure that the armature cable earth wire is connected to an M4 ring lug using one M4 screw provided and connect to the heatsink as shown in *Figure 6-22*. The maximum tightening torque is 1.5 Nm.

Warning: Ensure that fingers are clear from the saddle clamping area during the disengagement of the spring clamp onto the braid as serious injury could occur.

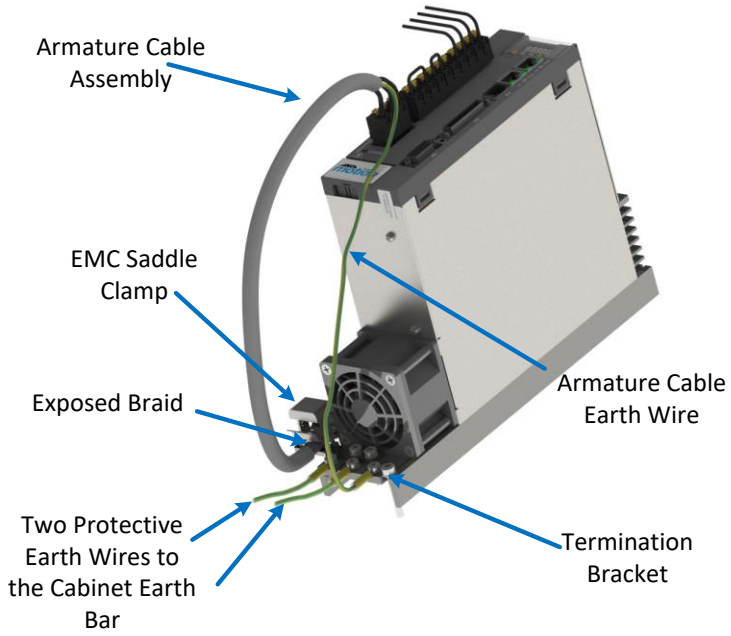


Figure 6-22 D2015 Armature Cable Shield Connection with Two PE Wires

6.8.2.4 Motor Armature Cable Braid Exposing Process

The armature cable braid must be exposed when mounting the EMC saddle clamp. To effectively expose the braid of the armature cable, the steps below should be followed:

1) Measure the required shield clamping position.
2) Using a shield removal tool, such as the STAR STRIP stripping tool from LAPP GROUP, score around the cable outer sheath while ensuring the braid is not cut.
3) At approximately 25mm away from the first incision, score around the cable outer sheath again.
4) Score the cable outer sheath lengthways between the first two incisions, and peel off the outer sheath and paper shield if there is any.

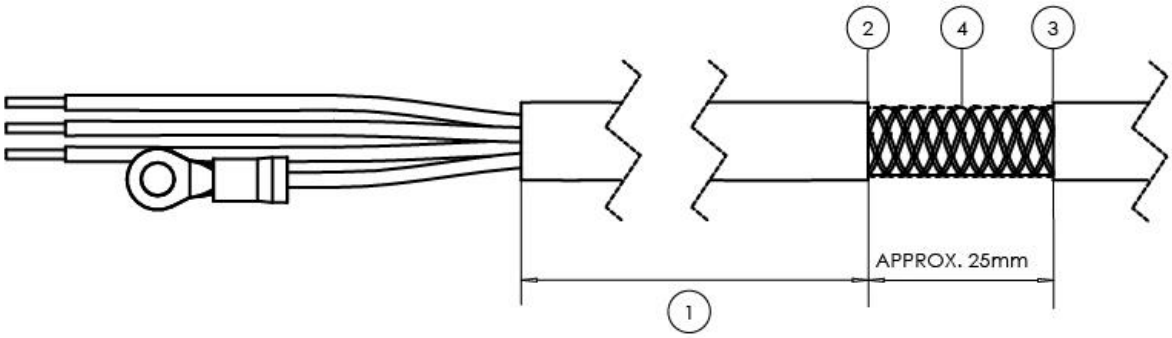


Figure 6-23 Armature Cable with the Braid Exposed

6.8.2.5 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:
   - Earth the cable shield close to the motor end, as shown in *Figure 6-24*.
   - Remove enough of the armature cable outer sheath to expose the metal braid. Be careful not to damage the braid in this process.
   - Attach a metal P-Clip to bare metal on the motor housing, or as close to the motor as possible. There must be a good electrical connection between the cable shield and the machine earth.

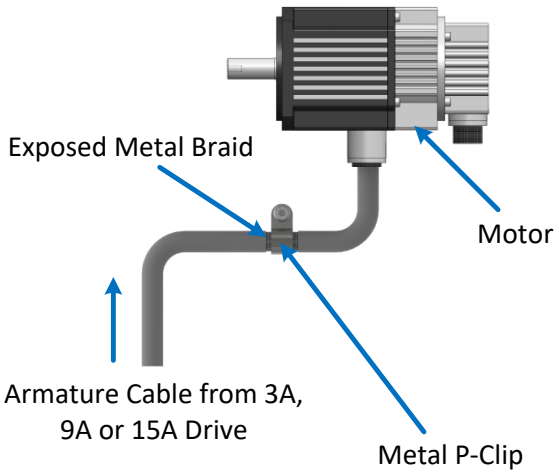


Figure 6-24 Armature Cable Shield Termination with Metal P-Clip at Motor End

Figure 6-25 shows a typical Earth Bar installation that may exist in the cabinet. Connect the Protective Earth of each drive in the cabinet to the earth bar using a star topology.

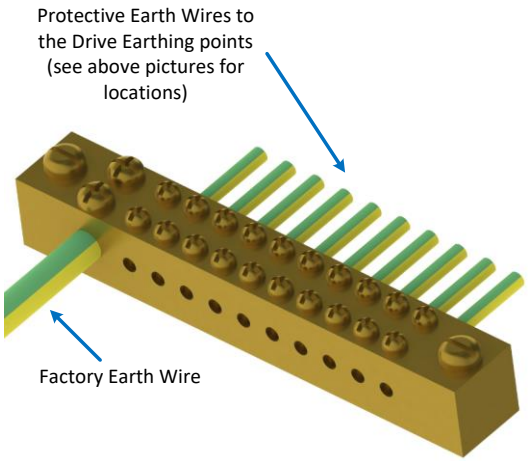


Figure 6-25 Use Star Topology to Connect Drive Protective Earth to Earth Bar

6.8.3 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 Vac, 240 Vac, 24 Vdc, analogue and 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.

6.9 Drive Output Filters

6.9.1 Sinusoidal Filter

Sinusoidal 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. Sinusoidal 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.

The recommended filter specifications for the various AMD2000 drive configurations is shown in *Table 6-8*.

Configuration	***Recommended Sinusoidal Filters***	***Recommended EMC Filter Specs[1]***		
		Rated Current	***Typical motor Power Rating***	***DC Link Voltage (Max)***
D2103 with no DC bus connection	3-phase 4A sine wave	4 A	1.5 kW	-
D2103 with DC bus connection	3-phase 4A sine wave	4 A	1.5 kW	850 V
D2109 with no DC bus connection	3-phase 12A sine wave	12 A	5.5 kW	-
D2109 with DC bus connection	3-phase 12A sine wave	12 A	5.5 kW	850 V
D2015 with no DC bus connection	3-phase 20A sine wave	20 A	11 kW	-
D2015 with DC bus connection	3-phase 20A sine wave	20 A	11 kW	850 V

Table 6-8 Recommended Sinusoidal Filter Specifications

[1]Motor frequency range is from 0-200Hz for these filters.

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

Standard sinusoidal filters are connected to the drive output as shown in *Figure 6-26*.

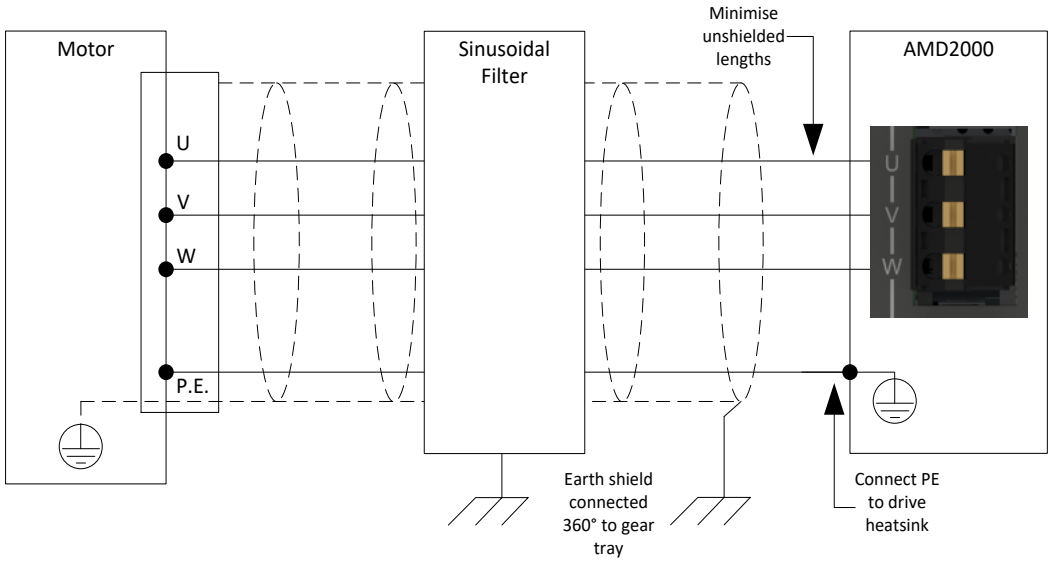


Figure 6-26 Motor Connections and Shielding with Standard Sinusoidal Filter

For more demanding applications, sinusoidal filters with DC bus connections can also be used as shown in *Figure 6-27*. There is an output voltage drop of approximately 5-10% across the sinusoidal filter.

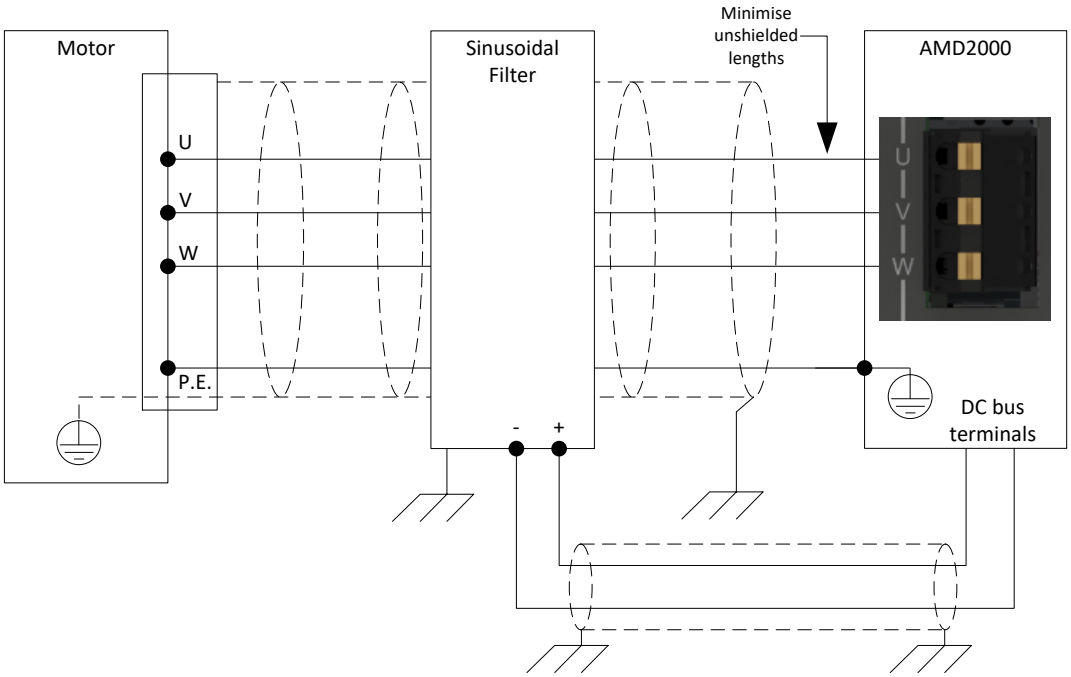


Figure 6-27 Motor Connections and Shielding and DC Link Sinusoidal Filter

6.9.2 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 sinusoidal 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.

6.10 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.

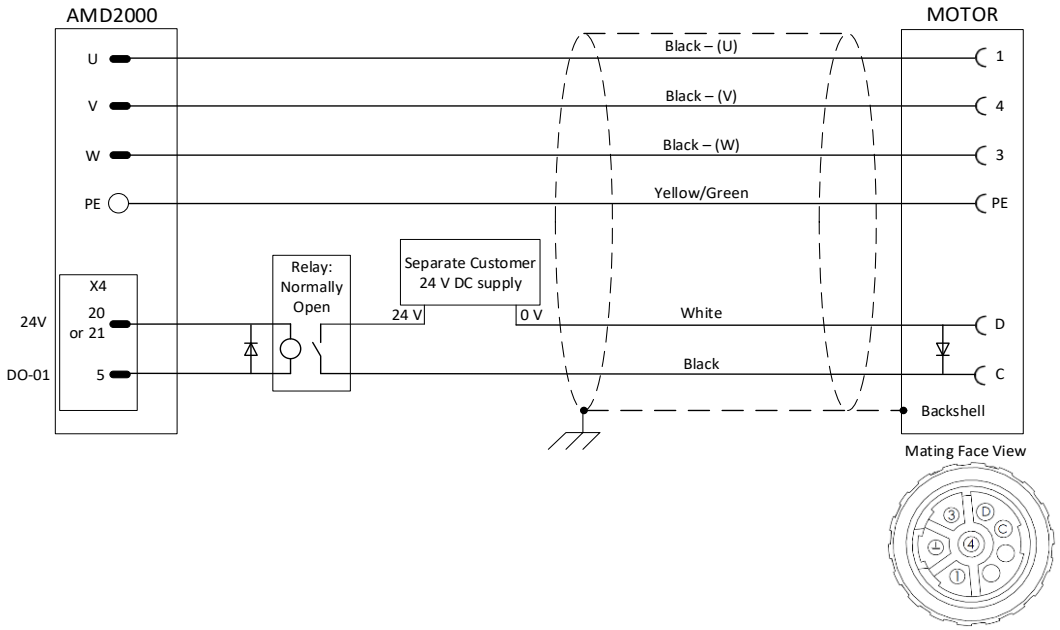


Figure 6-28 Example K2B-BSMD-xyz Armature with Brake Wiring

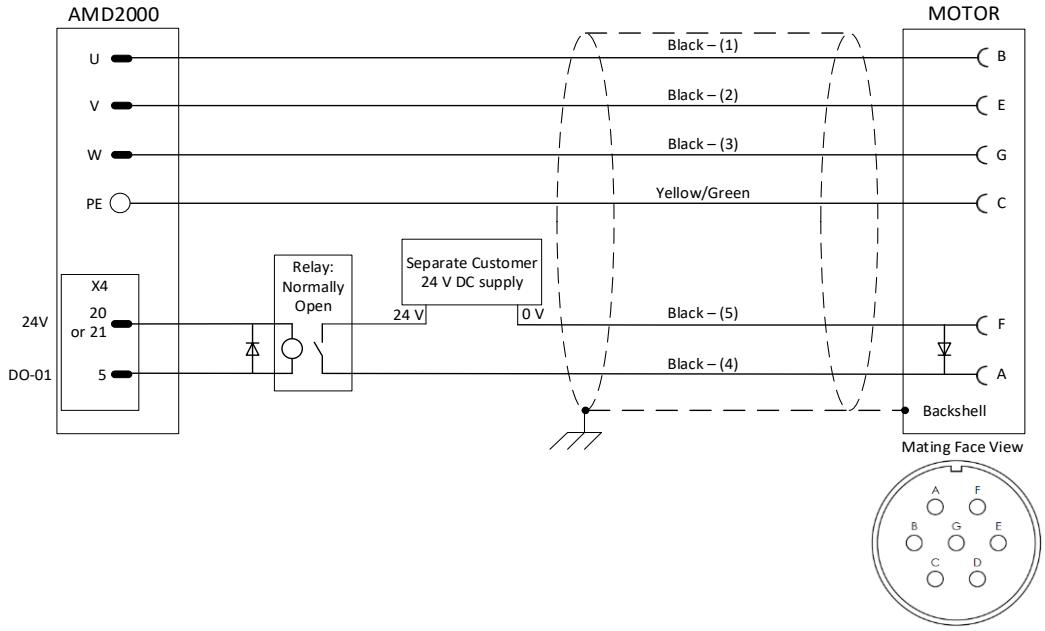


Figure 6-29 Example K2A-BSMD-xyz Armature with Brake Wiring

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 AMD2000 drive contains a configurable brake release delay after the motor is enabled to prevent undesired movement, refer to the *AMD 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 24 Vdc power supply for the brake must be a separate supply as brake wires often carry noise and generate large voltage spikes which may affect other devices connected to the brake supply. Do not use the drive 24V supply from X4 to power the brake. The separate 24 Vdc supply used for the motor brake can also be used to power the relay in the thermal switch circuit.

6.11 Motor Thermal Switch

Some motors provide a 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 6-30*.

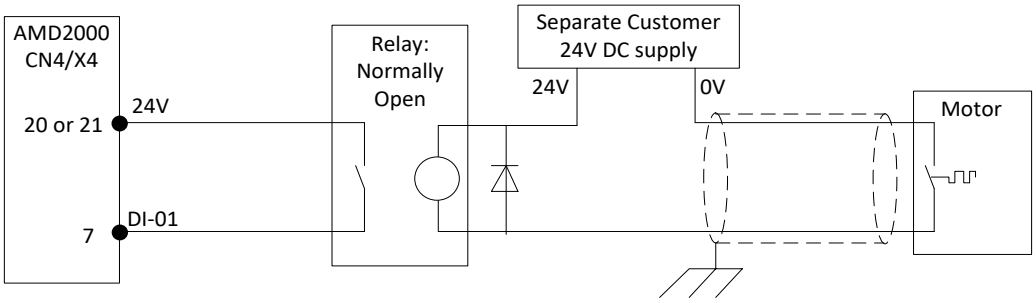


Figure 6-30 Motor Thermal Switch Interface Circuit

The 24 Vdc 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 AMD2000 drive 24V supply from X4 to power the thermal switch. The separate 24 Vdc 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 motor windings and the temperature sensor as required by IEC 60204-1 and referenced standards.

6.12 Motor Thermal Sensor

Some motors have an embedded temperature sensor to monitor the winding temperature. An analogue input on the AMD2000 drive can be used to provide temperature feedback, and the enduser must provide the appropriate scaling for the specific temperature sensor used. *Figure 6-31* shows a very simple example of connecting a PTC thermistor between Ain+ and Ain- using a simple voltage divider circuit. The thermistor has a non-linear response which is preset in the AMD2000 drive.

The preferred system is a motor with two co-located thermal sensors which can be wired in a bridge configuration as shown in *Figure 6-32*.This configuration has several advantages of a motor with a single thermal sensor:

- Increased signal-to-noise ratio as the bridge provides twice as much voltage per degree of temperature change.
- The resistance change in each leg of the bridge is balanced, so there is less impact on the measured voltage by changes in the load and the DC supply voltage.

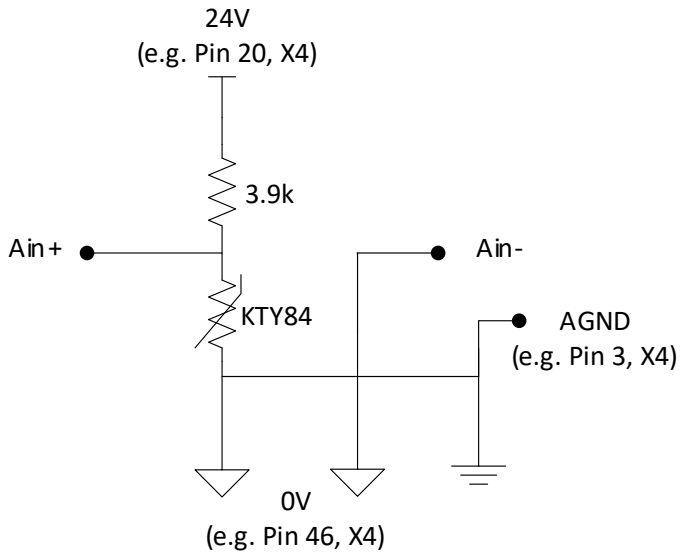


Figure 6-31 Connecting a Motor Thermal Sensor

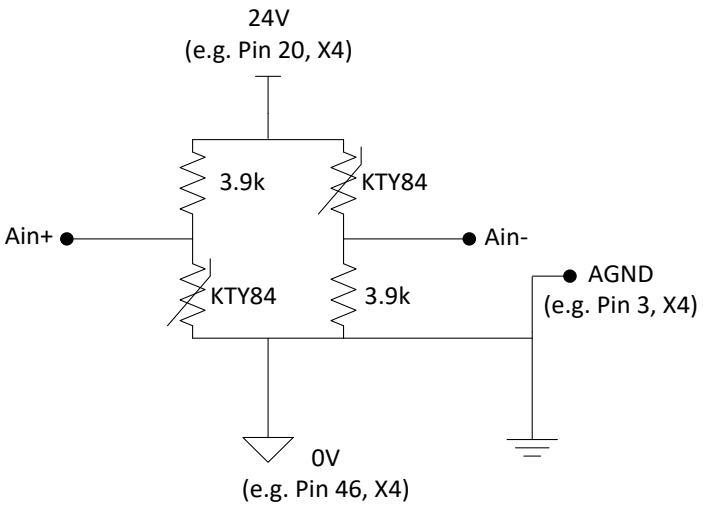


Figure 6-32 Connecting Two Thermal Sensors in a Bridge Configuration

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

Section *7.4.1.2* describes how to connect a PTC thermistor to an AMD2000 analogue input using the I/O Interface Module and Motor Thermistor Isolation Module.

6.13 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 *AMD Servo Drive SoE Configuration Guide* for details regarding the configuration of Motor Thermal Estimation.

6.14 Brake/Regeneration Resistor

The AMD2000 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

Table 6-9 Wiring for Internal and External Braking Resistors

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

Refer to section *10.4.5* for further information.

6.15 DC Busbar Terminals

Early AMD2000 drives from Manufacturing Year 2014 to 2020 included busbar screw terminals.
Drives manufactured since MY2020 do not provide busbar screw terminals.

6.15.1 Drive Models MY2014 to MY2020

Danger – High Voltage Area: If you need 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 manufactured between MY2014 and MY2020 contain 4 x DC busbar screw terminals. These terminals are located under the flip lid as shown in *Figure 6-33* and *Figure 6-34*. A clear plastic cover is fitted 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.

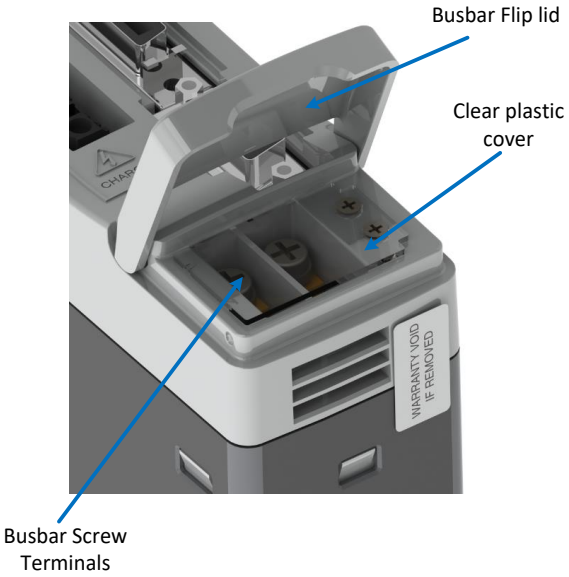


Figure 6-33 D2103 DC Busbar Screw Terminal Arrangement

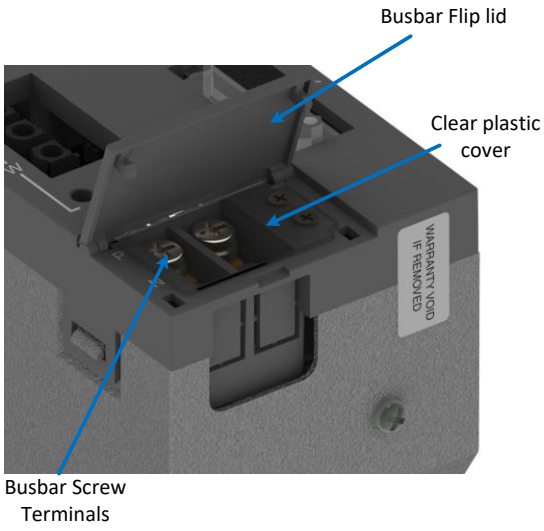


Figure 6-34 D2109 DC Busbar Screw Terminal Arrangement

6.15.2 Drive Models from MY2021

AMD2000 drives manufactured since MY2021 do not include the busbar terminals and therefore do not open the lid as there are no user accessible items inside.

6.15.3 Drive Date of Manufacture

Figure 6-35 shows how to interpret the date of manufacture from the serial number; for example, 0113 means year 2013 week 01.

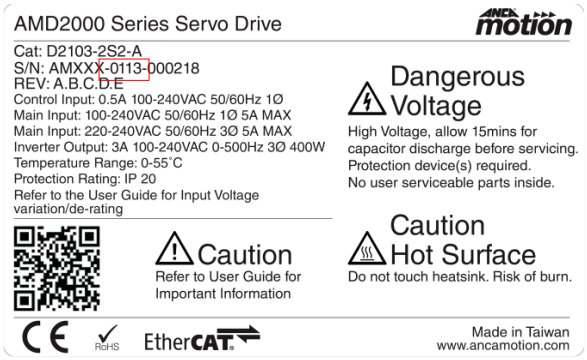


Figure 6-35 Date of Manufacture

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.

Warning: 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 I/O Connector X4

The control signals available on Port X4 are listed in *Table 7-1*:

Function	*Chapter*
Analogue inputs	*7.4.1*
Analogue outputs	*7.4.2*
24 Vdc supply	*7.5.1*
Digital inputs	*7.5.2*
Digital outputs	*7.5.3*
Encoder Pass-Through	*7.6*
Safe Torque Off	*7.7.5*

Table 7-1 Control Signals on I/O Connector X4

To access the control signals on I/O Connector X4, we recommend using the I/O Interface Module and I/O Interface Cable to ensure reliable operation of the Safe Torque Off (STO) function. Refer to Accessory sections *11.4.1* and *11.4.2* for ordering information. Refer to section *10.3* for detailed specifications.

The pin assignments for I/O Connector X4 are shown in *Figure 7-1*.

Pin	*Label*
1	AI-01+
2	AI-02+
3	AGND
4	AGND
5	SFR-A
6	SFR-B
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
20	+24V
21	+24V
22	DO-02
23	DO-03
24	DO-04
25	DO-05

Pin	*Label*
26	AI-01-
27	AI02-
28	AO-01+
29	AO-02+
30	AGND
31	AGND
32	N/C
33	N/C
34	DO-06
35	EO-A+
36	EO-A-
37	EO-B-
38	EO-B+
39	EO-Z-
40	EO-Z+
41	N/C
42	N/C
43	STO-01-
44	N/C
45	STO-01+
46	GND (24V)
47	GND (24V)
48	N/C
49	STO-02+
50	STO-02-

Figure 7-1 I/O Connector X4

Warning: I/O Connector X4 pin assignments are provided, but ANCA Motion cannot ensure reliable operation of the STO function if the user supplies their own cable and connector.

7.3 I/O Interface Module

All digital and analogue I/O from the X4 connector can be made available using the I/O Interface Module.

- The 24V ground reference (pins 46 and 47) are exposed by two grounding terminals on the right of the module. Terminate these at the gear tray grounding point, using 0.5mm^2 to 2.5mm^2 conductor, refer to *Figure 7-2*.
- Every pin from the X4 connector is broken out to spring-cage terminal blocks.
- The terminal blocks can accept 0.25mm2 to 1.5mm2 conductors with 7mm stripping length.
- The module is mounted using 35mm top hat DIN rail (EN 60715).

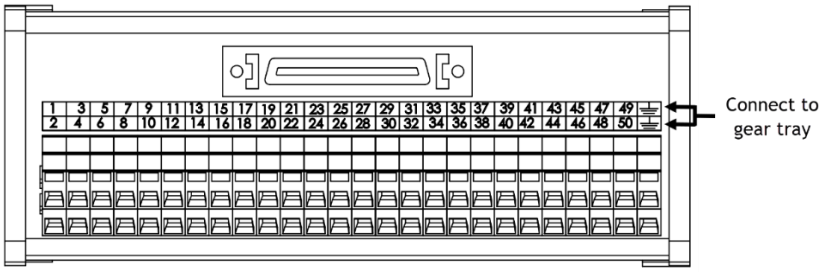


Figure 7-2 I/O Interface Module

7.4 Analogue I/O

All analogue input and output signals are available at connector X4 or the I/O Module according to *Table 7-2*.

Refer to section *10.3* for detailed specifications.

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

Table 7-2 Analogue Input and Output Pins

7.4.1 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. Refer to *AMD Servo Drive SoE Configuration Guide* for detailed information on how to use ANCA MotionBench to read analogue input values.

An idealized drawing of the analogue input circuit is shown in *Figure 7-3*.

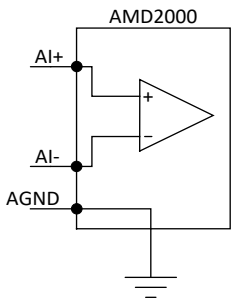


Figure 7-3 Idealized Analogue Input Circuit

7.4.1.1 Typical Analogue Input Connection Examples

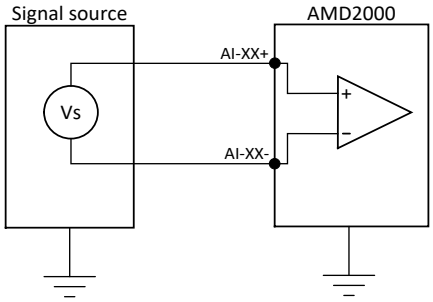


Figure 7-4 Typical Example of Floating Differential Input Connection

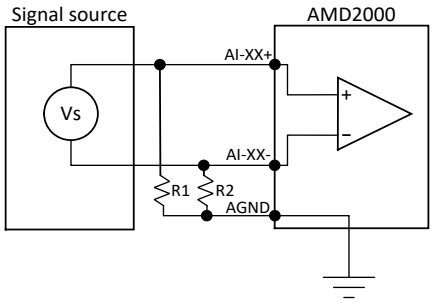


Figure 7-5 Typical Example of Ground-Referenced Differential Input Connection

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.

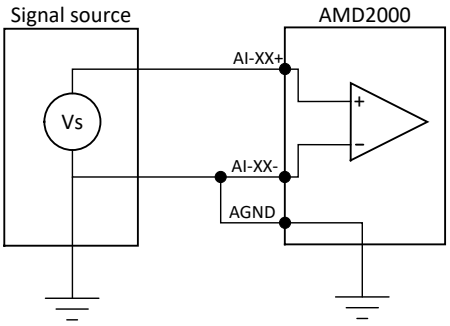


Figure 7-6 Typical Example of Ground Referenced Single-Ended Connection

Note: In the scenario presented in *Figure 7-6*, 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.

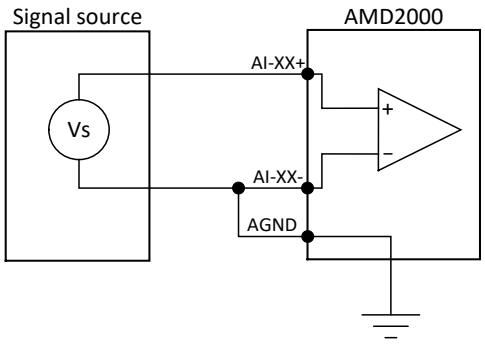


Figure 7-7 Typical Example of Floating Single-Ended Connection

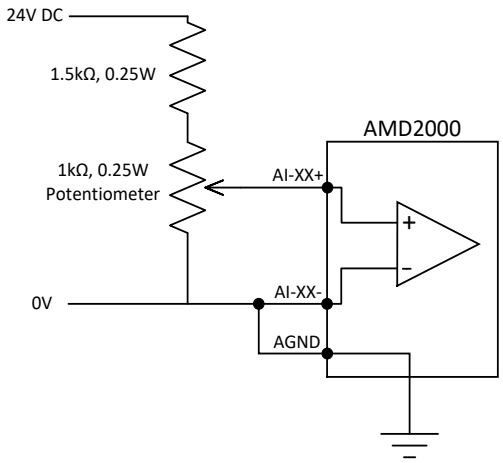


Figure 7-8 Typical Input Circuit to Provide 0-10V Input from a 24V Source

7.4.1.2 Motor Thermistor Isolation Module

The Motor Thermistor Isolation Module is an optional accessory to provide galvanic isolation between the servo drive PELV and a potentially dangerous thermistor embedded in the motor. In this respect, the Motor Thermistor Isolation Module achieves reinforced isolation with respect to a 300 Vrms system. Refer to Accessories section *11.4.8* for ordering information.

The Motor Thermistor Sensor Isolation Module is intended to be used with the I/O Interface Module to access the analogue inputs of the AMD2000 drive (refer to section *11.4.2*).

This module has outputs ANAO+ and ANAO-, of which are short-circuit protected for shorts to each other, and shorts to GND. They are NOT protected against a short to the 24V supply.

Connection detail for the Motor Thermistor Isolation Module is shown in *Figure 7-9* and *Table 7-3*.

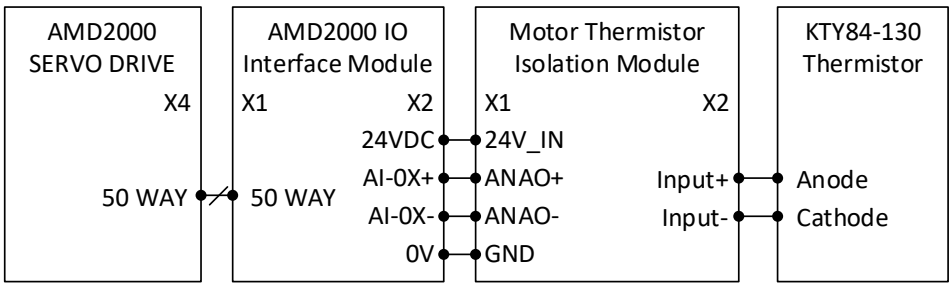


Figure 7-9 Motor Thermistor Isolation Module Connection Overview

Connector	*Pin Number*	*Label*	*Function*
X1	1	0V	0V
	2	ANAO-	Analogue Output -
	3	ANAO+	Analogue Output +
	4	+24V	24 Vdc
X2	1	-	Thermistor Input -
	2	+	Thermistor Input +

Table 7-3 Motor Thermistor Isolation Module Pin Configuration

Refer to section *10.6.2* for technical specifications of the Motor Thermistor Isolation Module.

7.4.2 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 *AMD Servo Drive SoE Configuration Guide* for detailed information on how to use ANCA MotionBench to read analogue output values.

An idealized drawing of the analogue output circuit is shown in *Figure 7-10*.

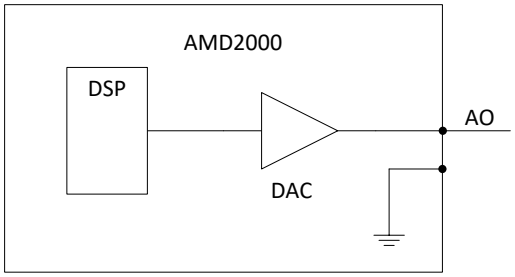


Figure 7-10 Idealized Analogue Output Circuit

7.5 Digital I/O

The AMD2000 provides 8 digital inputs, 2 differential digital inputs, and 6 digital output signals:
The digital input and output signals available on connector X4 are listed in *Table 7-4*.

X4 Pin Number	*Label*
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	0 Vdc

Table 7-4 Connector X4 Digital I/O

Refer to section *10.3* for detailed specifications of the digital I/O.

[1] Refer to specifications section *10.3* for the maximum current rating of the 24V output.

Table 7-5 lists the digital input and output signals available with the optional I/O Interface Module connected to X4. Ordering information for the I/O Interface Module can be found in Accessories section *11.4.2.*

Pin Number	*Label*	*Function*
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+	Digital 0V
16	DI-09-	Single-ended Digital Input
17	DI-010+	Digital 0V
18	DI-10-	Single-ended Digital 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[1]	+24V
46, 47	0 Vdc	Digital 0V
48-50	Not Connected	
51	GND	Digital GND
52	GND	Digital GND

Table 7-5 Digital I/O with Interface Module

[1] Refer to specifications section *10.3* for the maximum current rating of the 24V output.

7.5.1 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 for this 24V control supply is 0 Vdc (X4 pins 46 & 47). This reference ground must be connected to the chassis ground (gear tray), to establish a “control ground” for the installation.

7.5.2 Digital Inputs

Digital Input Overview

- DI-01 – DI08 are electrically isolated through opto-couplers.
- DI-09 – DI10 are not isolated.
- Reference 0V is 0 Vdc (X4 pins 46 & 47)

Refer to *AMD Servo Drive SoE 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

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

Figure 7-11 shows an idealized drawing of the general purpose digital input circuit.

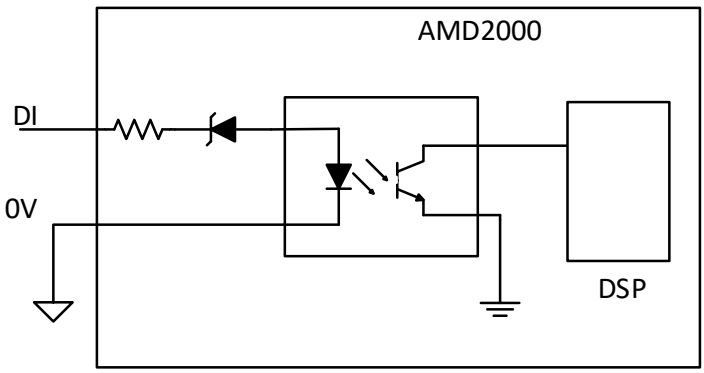


Figure 7-11 Idealized Digital Input Circuit

7.5.2.1.1 Typical Connection Example of Digital Input

Figure 7-12 shows a typical application of the general-purpose digital input.

Warning: If the 24V supply is used to switch I/O devices, refer to Specifications section *10.3* for current rating information.

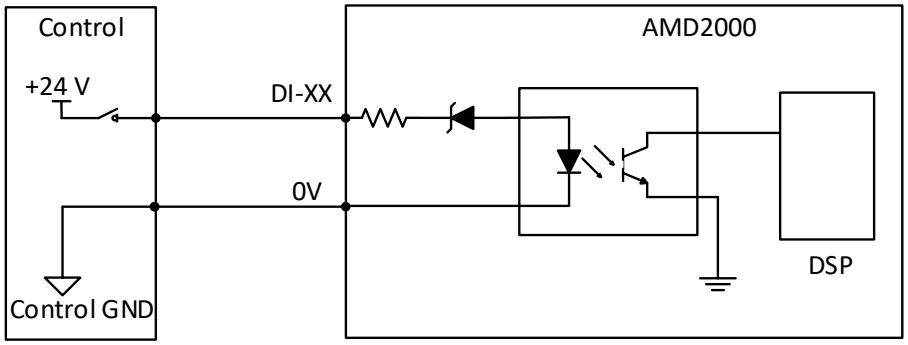


Figure 7-12 Typical Example of a Digital Input Connection

7.5.2.1.2 Typical Connection Example of NPN Device

Figure 7-13 shows a typical example of connecting an open-collector device to the general-purpose digital input.

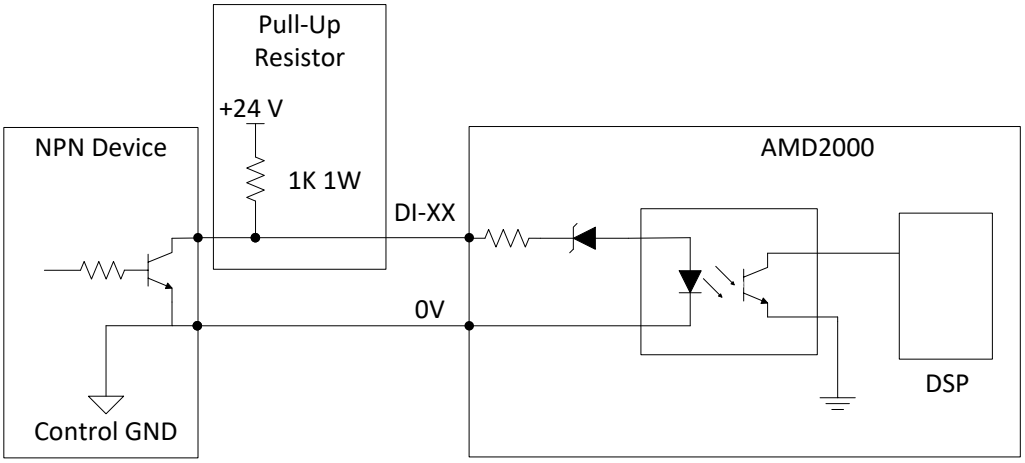


Figure 7-13 Typical Example of Connecting an Open Collector Device

7.5.2.2 Differential Inputs DI-09 & DI-10

Figure 7-11 shows an idealized drawing of the differential digital input circuit.

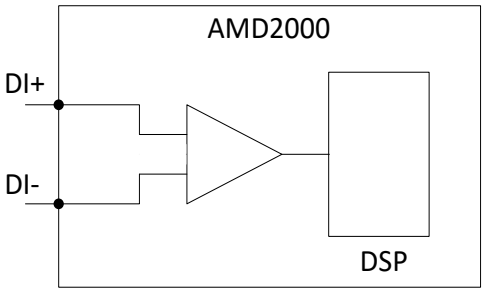


Figure 7-14 Idealized Differential Input Circuit

If additional digital inputs are required, the two differential inputs can be configured as general purpose digital inputs using the optional I/O Interface Module (see section *11.4.2*).

7.5.2.2.1 Connecting PNP and NPN Based Sensors

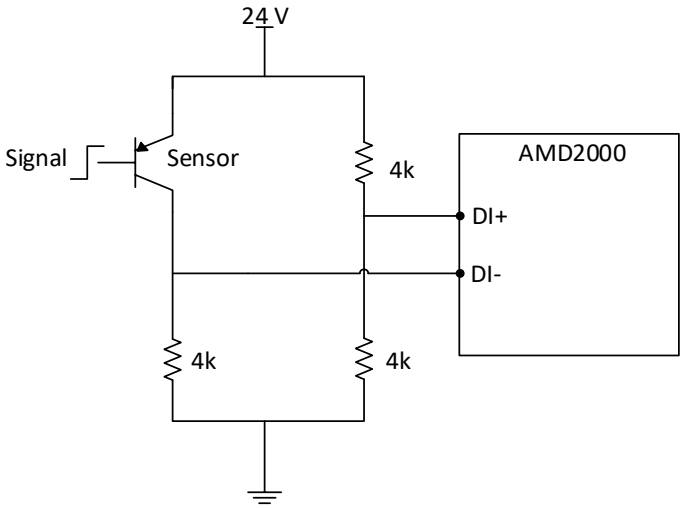


Figure 7-15 - Example PNP Based Sensor

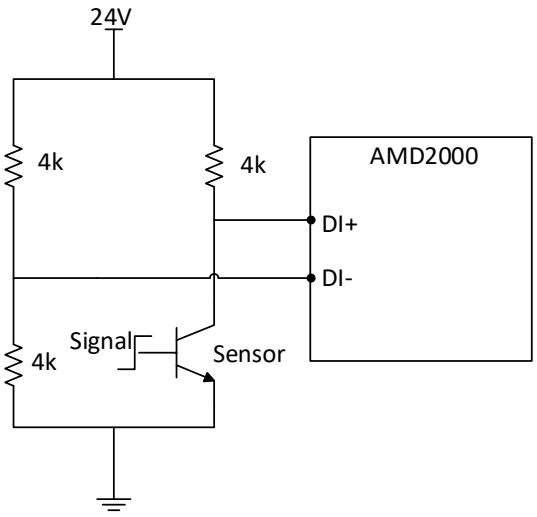


Figure 7-16 – Example NPN Based Sensor

7.5.2.2.2 Connecting 24V Single-ended Signals Using the I/O Interface Module

Figure 7-17 shows a typical single-ended digital input when using the optional AMD2000 I/O Interface Module.

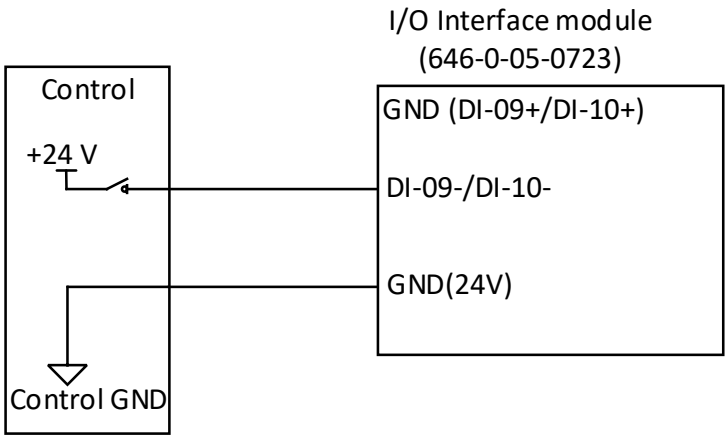


Figure 7-17 – Interface with 24V Single-ended Signals

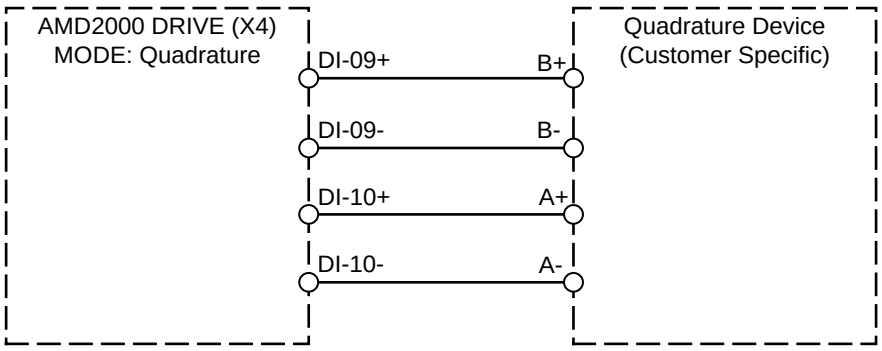
Specifications for the digital input signals when using the optional AMD2000 I/O Interface Module are shown in *Table 7-6*.

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

Table 7-6 Digital Input Specifications

Refer to section *10.3* for detailed specifications.

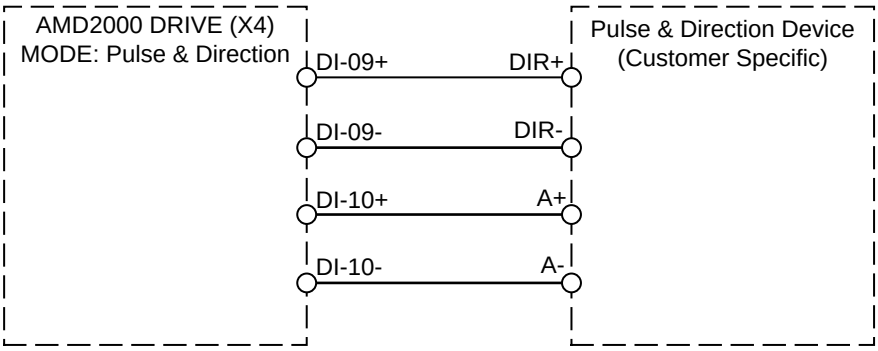
7.5.2.2.3 Connecting a Differential Quadrature Pulse Position Input Device



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 7-18 - Differential Quadrature Mode Wiring Diagram

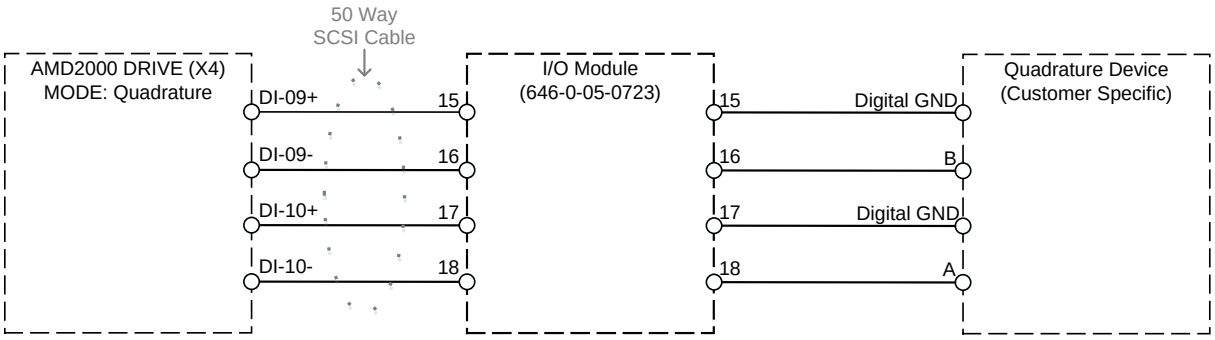
7.5.2.2.4 Connecting a Differential Pulse and Direction Position Input Device



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 7-19 - Differential Pulse and Direction Mode Wiring Diagram

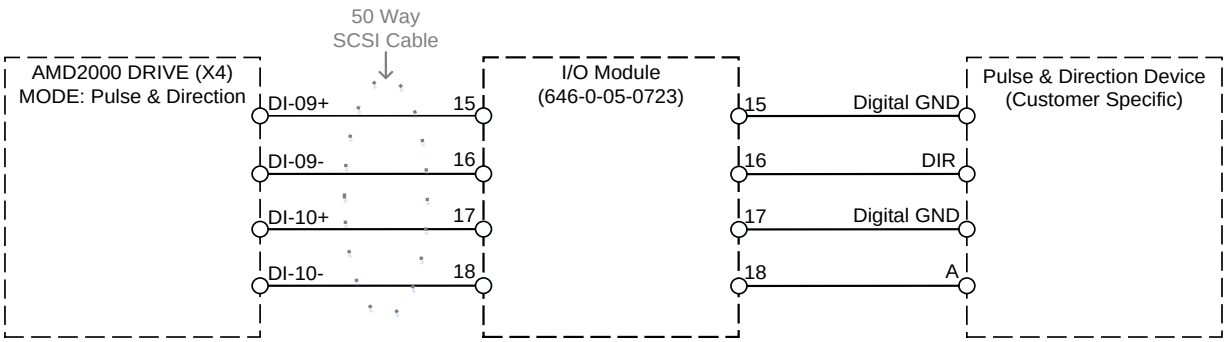
7.5.2.2.5 Connecting a Single Ended Quadrature Pulse Position Input Device



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 7-20 - Single Ended Quadrature Mode Wiring Diagram

7.5.2.2.6 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 7-21 - Single Ended Pulse and Direction Mode Wiring Diagram

7.5.3 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 Specification section *10.3* for maximum current ratings.
- All Digital outputs are pulled to ground.

Refer to *AMD Servo Drive SoE Configuration Guide* for detailed information on how to use ANCA MotionBench to read digital output values.

Figure 7-22 shows an idealized drawing of the digital output circuit.

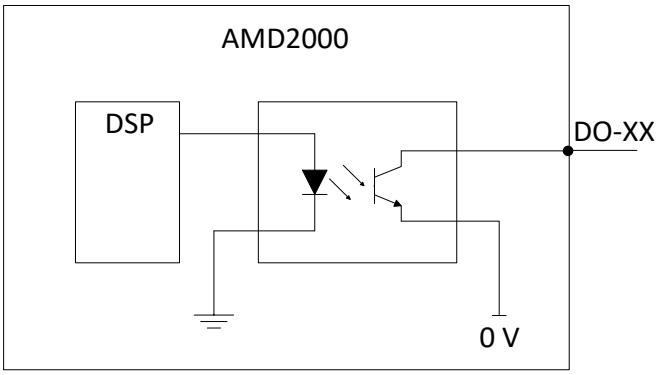


Figure 7-22 Idealized Digital Output Circuit

7.5.3.1 Typical Connection Examples

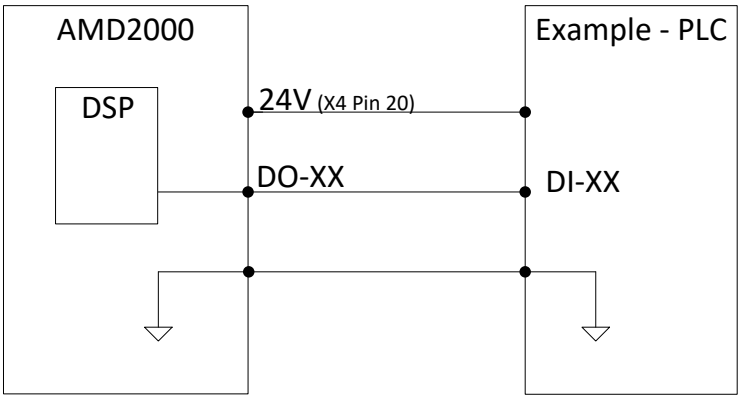


Figure 7-23 Digital Output Example with PLC

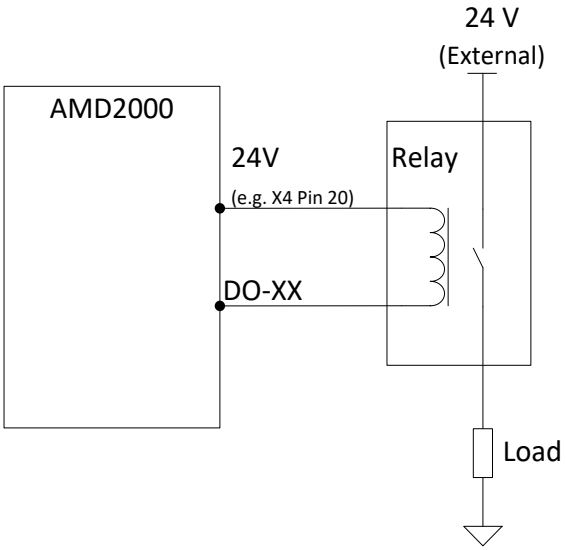


Figure 7-24 Digital Output Example with Relay

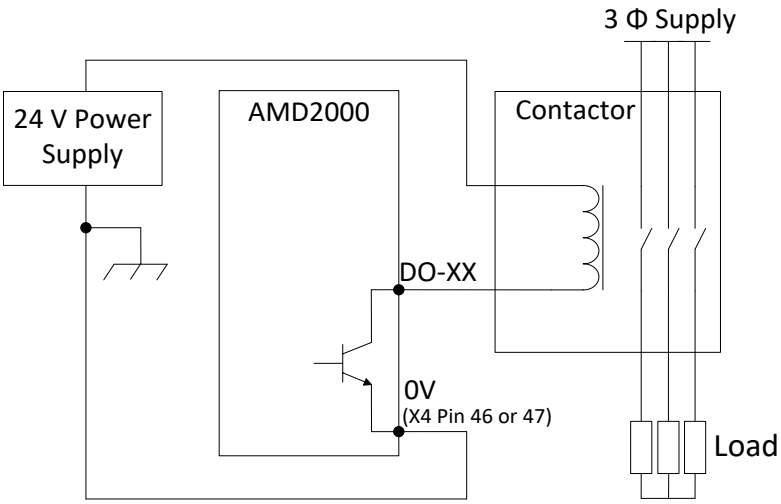


Figure 7-25 Digital Output Example with Contactor

7.6 Encoder Pass-Through

An encoder pass-through is available via connector X4. It provides access to either the analogue or digital encoder input supplied on connector X5. The differential output signals are in the form of an incremental encoder.

Connector	*Pin Number*	*Label*
X4 or I/O Module	35	EO-A+
	36	EO-A-
	37	EO-B-
	38	EO-B+
	39	EO-Z-
	40	EO-Z+

Table 7-7 Encoder Pass-Through via Connector X4

7.7 Safe Torque Off (STO) Operation

7.7.1 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 *Demanded* 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.

Table 7-8 STO Definitions

7.7.2 STO Overview

The AMD2000 STO drives (models D2103 and D2109) have 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.[1]

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 asserted for the drive to be enabled. In this condition, the STO safety function is not asserted. STO has detected no faults (internal or external) and has received no demand to activate. I/O Interface Module and cable are required to setup STO (see Accessories section *11.4.2* and *11.4.1* for ordering information) 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. Refer to section for more information on the external power supply requirements.

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

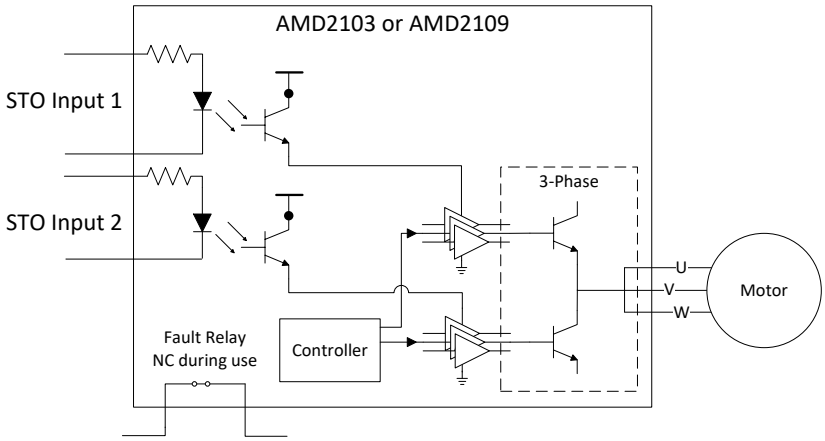


Figure 7-26 STO Implementation

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 manual 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.

Warning: When using a 3-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).

7.7.3 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*).
- 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 *7.7.8*) 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 (see section *11.4.5*) 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.

7.7.4 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. The STO input requirements are shown in *Table 7-9*.

STO input	*Nominal*	*Maximum*	*Units*
Input Voltage	24 (±20%)	30	Vdc
Input Current	-	10	mA

Table 7-9 STO Input Ratings

Warning: If either STO input is energised above 30 Vdc the drive may be damaged.

STO is activated (i.e. asserted) when power is removed from either STO input for a duration longer than the time shown in *Table 7-12*. Correct operation requires both inputs to be asserted or de-asserted simultaneously within the specifications shown in *Table 7-12* STO Timing Specifications; and longer times will cause a diagnostic fault. In either situation, the drive will achieve its Safe State and no energy will be supplied to the motor.

The maximum time between asserting the STO inputs and blocking the energy to the motor is a SILCL 3 certified safety function, see *Table 7-12*.

The maximum time between operating a STO fault relay and blocking the energy to the motor is a SILCL 3 certified safety function, see *Table 7-12*.

STO fault detection, timing diagrams, and timing specifications are described in detail in section *7.7.6*).

Depending on the operating mode of the drive, STO assertion (without faults) results in two different outcomes:

1. If the drive was in an 'enabled' state when STO was asserted, the drive will register an error 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;[1]
    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 (i.e. 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.'

[1] Refer to *AMD Servo Drive SoE Configuration Guide* for instructions to clear drive errors or disable and re-enable the drive.

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[1]) in order to recover to under normal operating conditions (i.e. no faults[2]). 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 must be set running again.

Note: When asserting or de-asserting STO, both STO inputs must change within the timing window specified in *Table 7-12* or the drive may trigger a fault reaction as described in *7.7.6.*

Note: The AMD2000 STO drives will not respond to very short duration STO assertions (0V) as long as the intervening periods of de-assertion (24V) are much longer as specified in *Table 7-12*.

Warning: The AMD2000 STO drives will respond to a sequence of short STO assertions (0V) if the intervening periods of de-assertion (24V) are also short as specified in *Table 7-12*.

7.7.5 STO Wiring with the I/O Interface Module

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

This section includes STO wiring diagrams for various single and multiple-drive configurations when using the optional I/O Interface Module described in section *11.4.2*.

The STO connections for the I/O Interface Module are shown in *Table 7-10*.

Terminal Number	*Function Name*	*STO Input*	*Internal Supply*
45	+STO 1	+24 Vdc	-
43	-STO 1	0 Vdc	-
49	+STO 2	+24 Vdc	-
50	-STO 2	0 Vdc	-
5	SFR-A	+24 Vdc	-
6	SFR-B	+24 Vdc	-
20 & 21	+24V	-	+24 Vdc
46 & 47	0V	-	0 Vdc

Table 7-10 - I/O Interface Module 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 15m in length. Avoid tight bending and installations leading to abrasion in the cable.

[1] 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.
[2] 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.

If STO is not required for machine safety, then both STO channels can be connected to the 24 Vdc internal supply (*Table 7-10*) as described in section *7.7.5.5*.

Alternatively, STO functionality can be disabled using optional accessory STO Override Plug connected to connector X4 (refer to Accessories section *11.4.5* for ordering information).

Several common external failure modes result in safe state via the action of the STO function:

- If a STO input (I/O 45,43 and/or I/O 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 (e.g. 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 *AMD Servo Drive SoE Configuration Guide.*

7.7.5.1 Single Drive STO Wiring

When using a single AMD2000 drive in a machine, the STO wiring may be wired as shown in *Figure 7-27*.

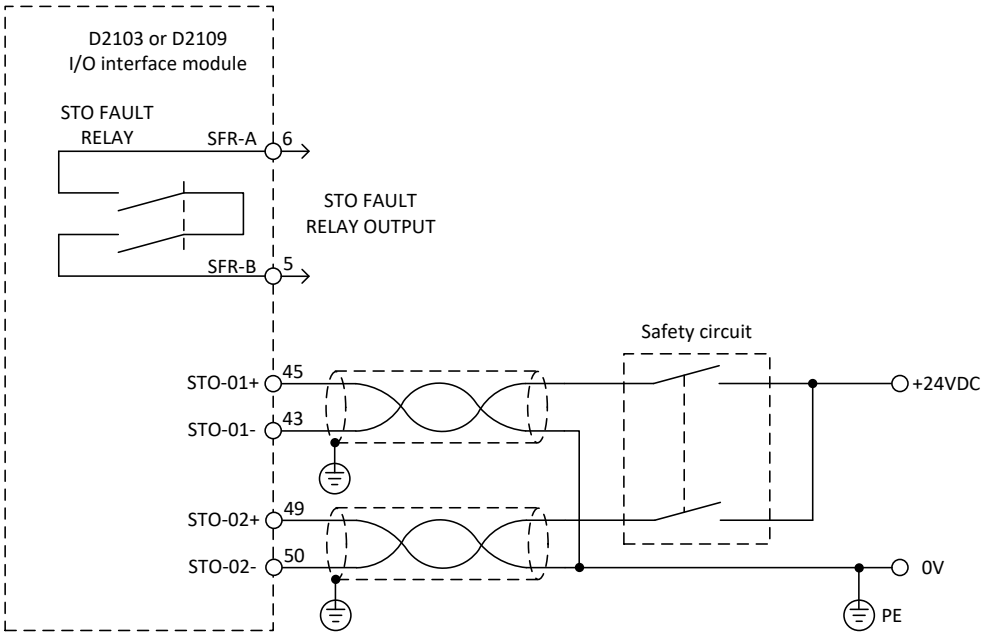


Figure 7-27 Single Drive STO Wiring Example

Note: The internal +24V power supply has a limited output capability (refer to *Table 7-9*). 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.

7.7.5.2 Multiple Drive STO Wiring

When using multiple drives in a machine, the STO wiring may allow daisy chaining to each of the drives as shown in *Figure 7-28*.

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 +24 Vdc power supply. The external power supply must meet the voltage and current requirements of *Table 7-9* and the required current draw depends on the number of drives in parallel.

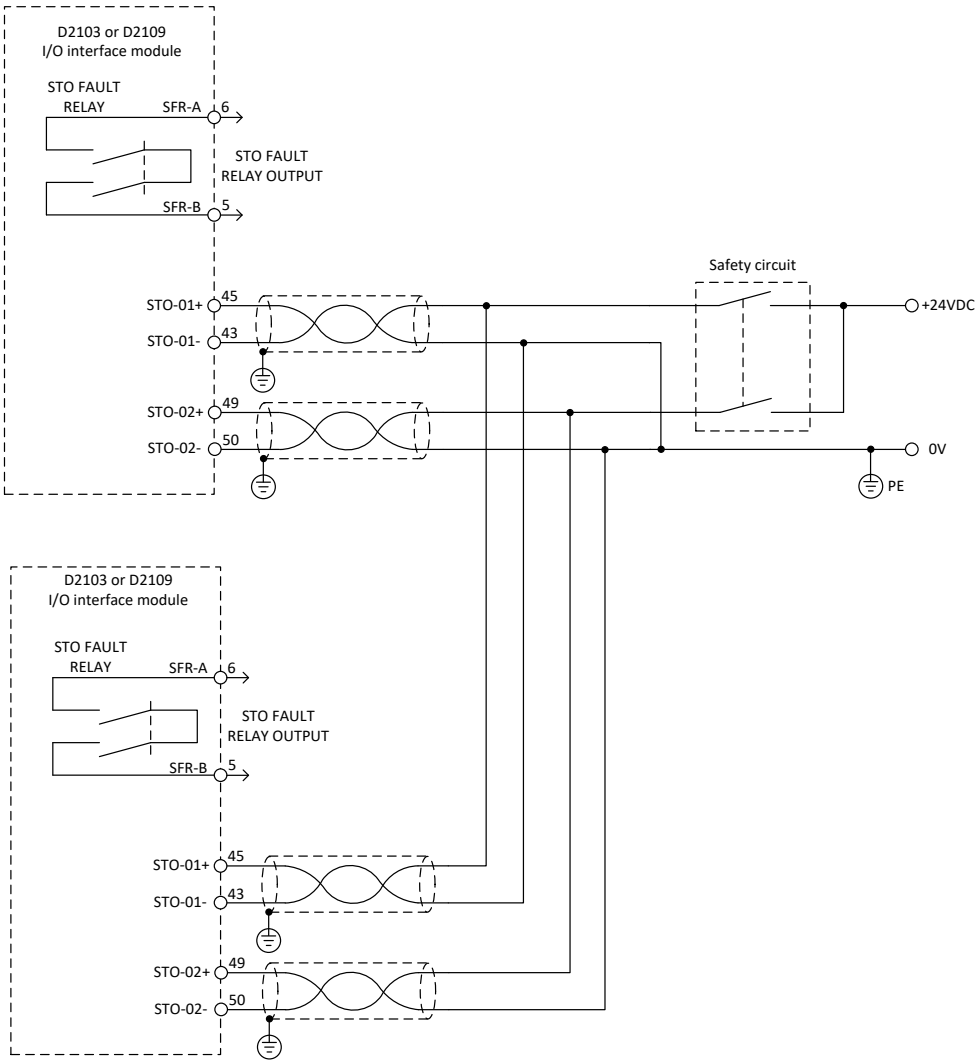


Figure 7-28 Multiple Drive STO Wiring Example

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 *Table 7-9*). Failure to do so may result in activation of over current protection and may therefore cause unexpected STO activation.

7.7.5.3 Single Drive STO Wiring with a Safety Module

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

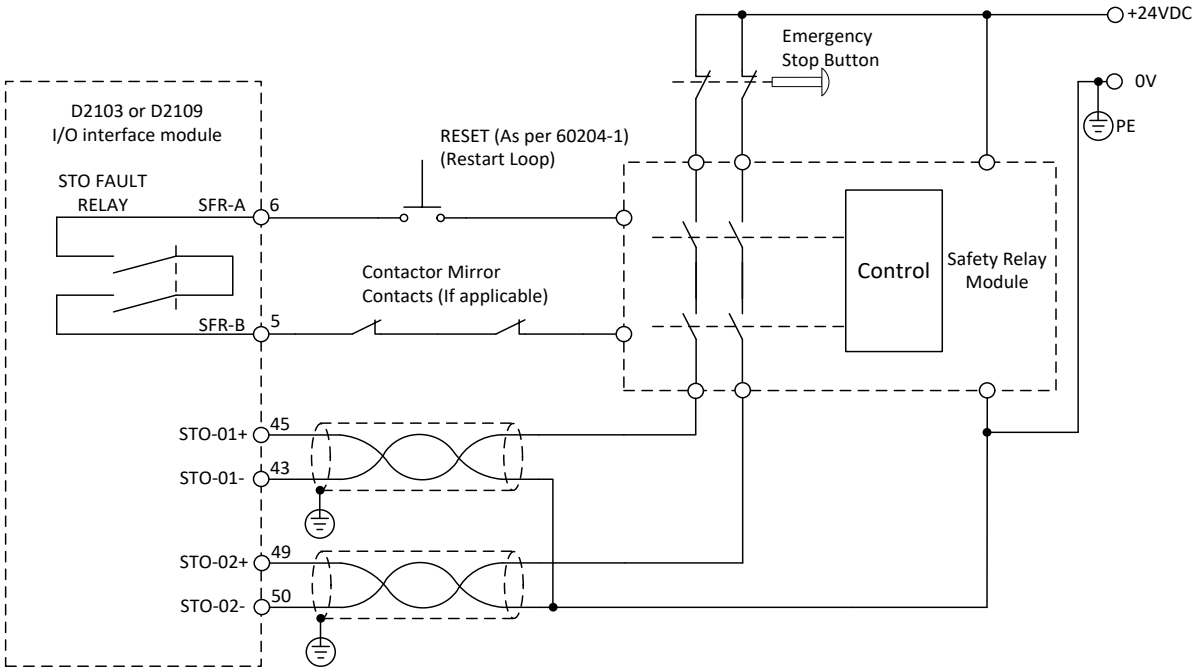


Figure 7-29 Example of Integrating a Single STO Drive to a Safety Circuit

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.

7.7.5.4 Multiple Drive STO Wiring with a Safety Module

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

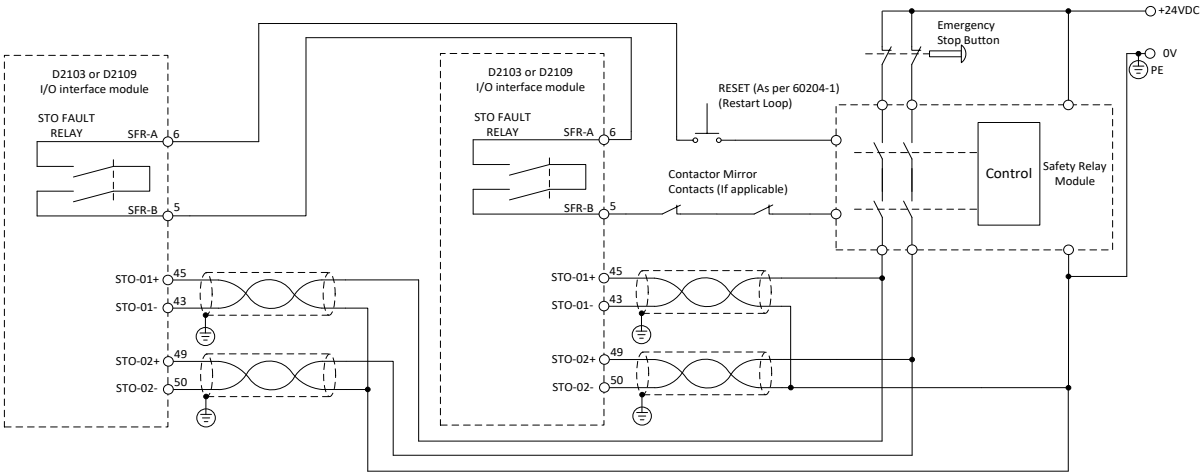


Figure 7-30 Example of Integrating Two STO Drives to a Safety Circuit

Notes:

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 *Table 7-9*). Failure to do so may result in activation of over current protection and may therefore cause unexpected STO activation.

7.7.5.5 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 7-31*. Without this wiring the drive cannot operate. Also, refer to the note in *Table 7-9* 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.

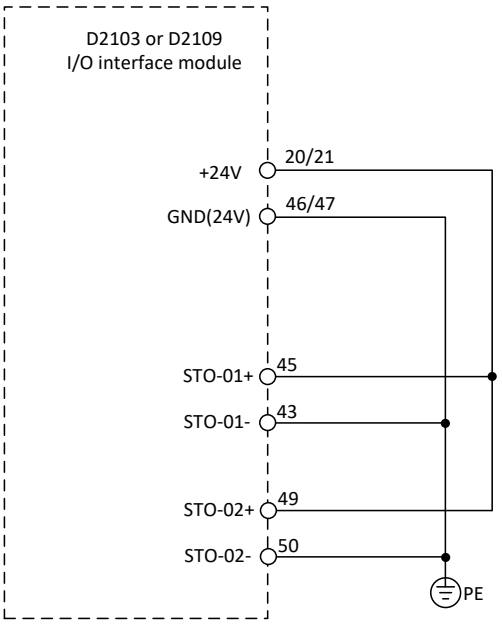


Figure 7-31 STO Feature Not Used

7.7.6 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.

Examination of the STO inputs provides *external detection*. For correct operation of STO, both 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 7-32* and *Table 7-12* for more details.

Examination of the power delivered to both high and low side opto-couplers to the gates provides *internal detection*. 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 7-11* 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 7-11 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.

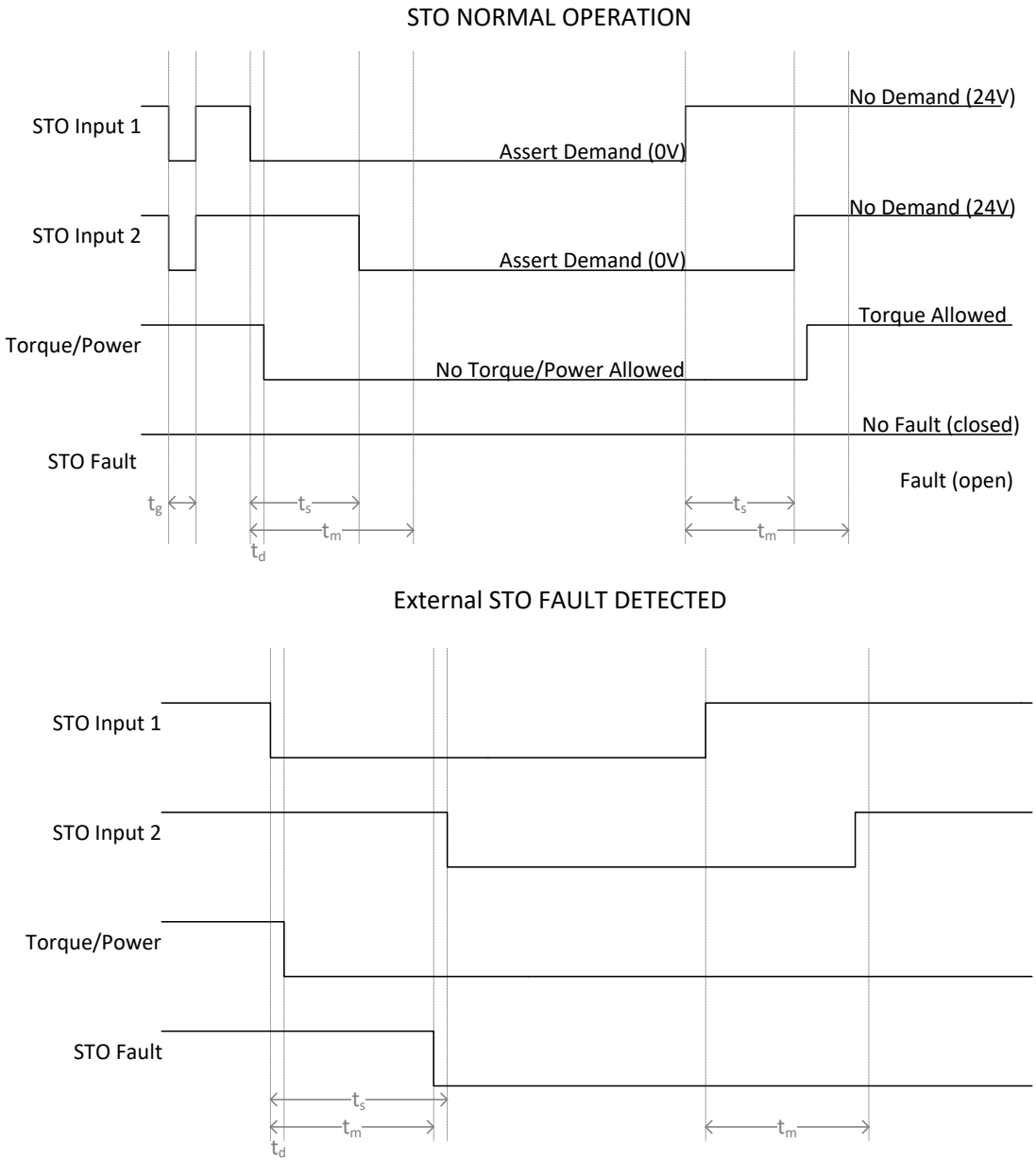


Figure 7-32 STO Timing Diagrams

Parameter	*Description*	*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[1]
t_m	Maximum time allowable between differing STO demands before external fault detected	120	240

Table 7-12 STO Timing Specifications

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

7.7.7 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 *AMD Servo Drive SoE 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 *AMD Servo Drive SoE 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 section *7.7.6*) 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.

7.7.8 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 7-33*.

Follow the flow charts described on the following pages 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.

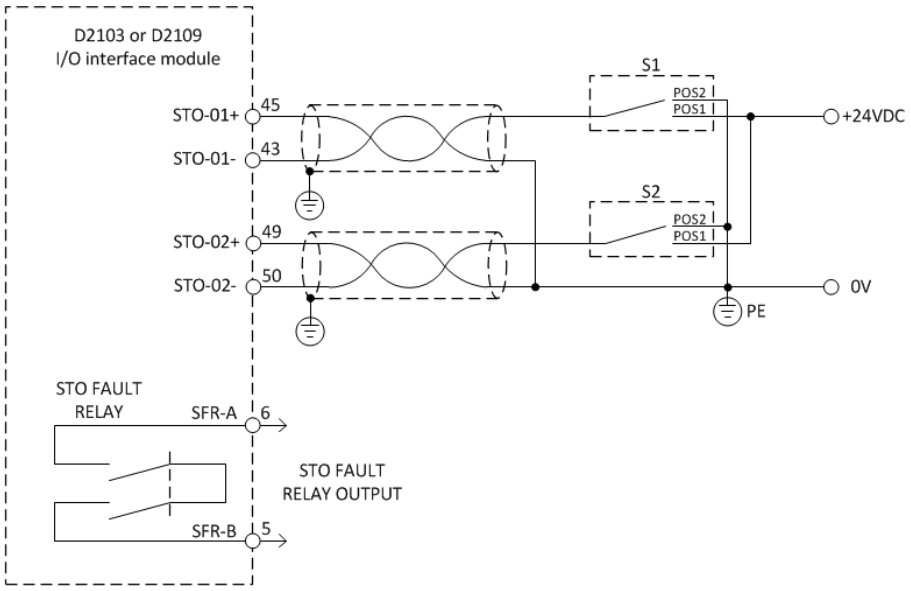


Figure 7-33 STO Test Setup

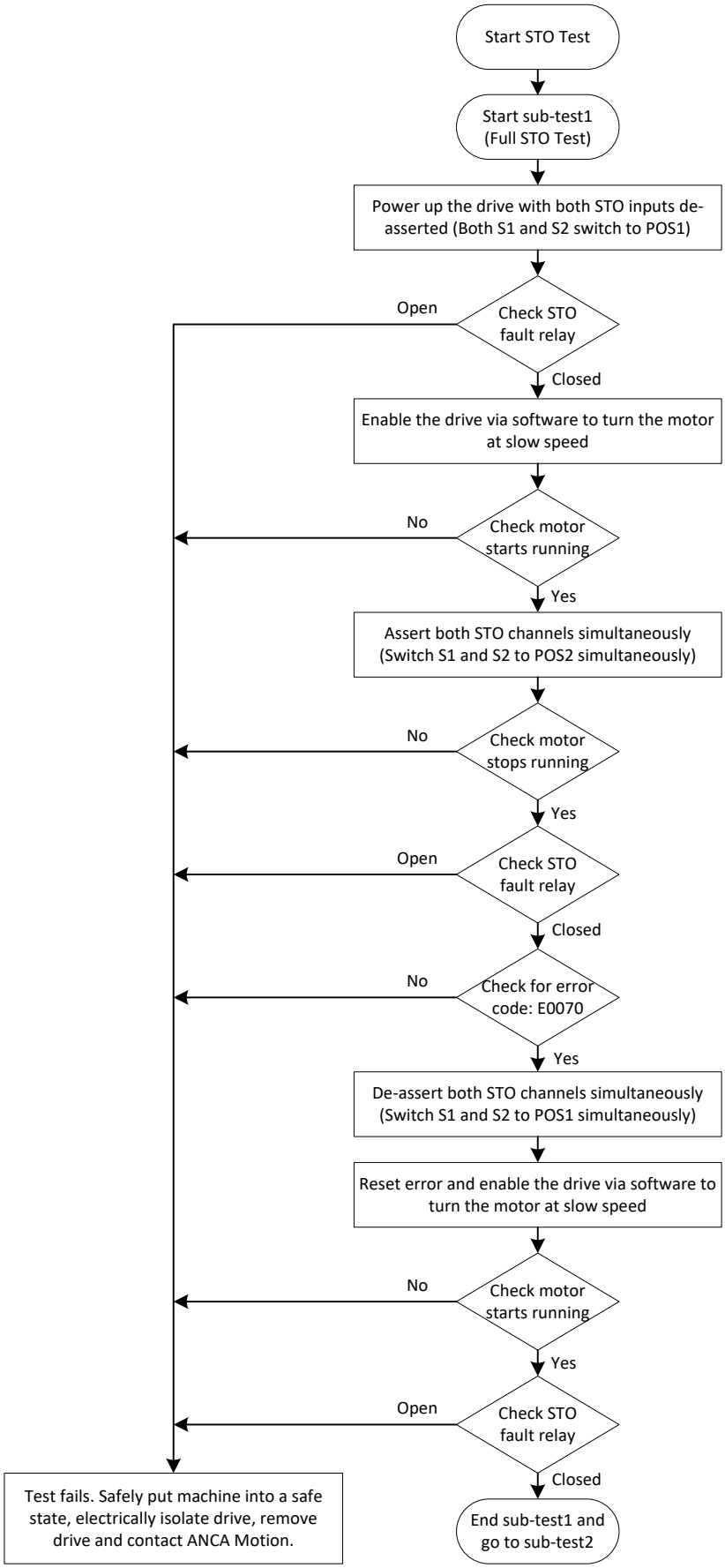


Figure 7-34 STO Sub-Test 1

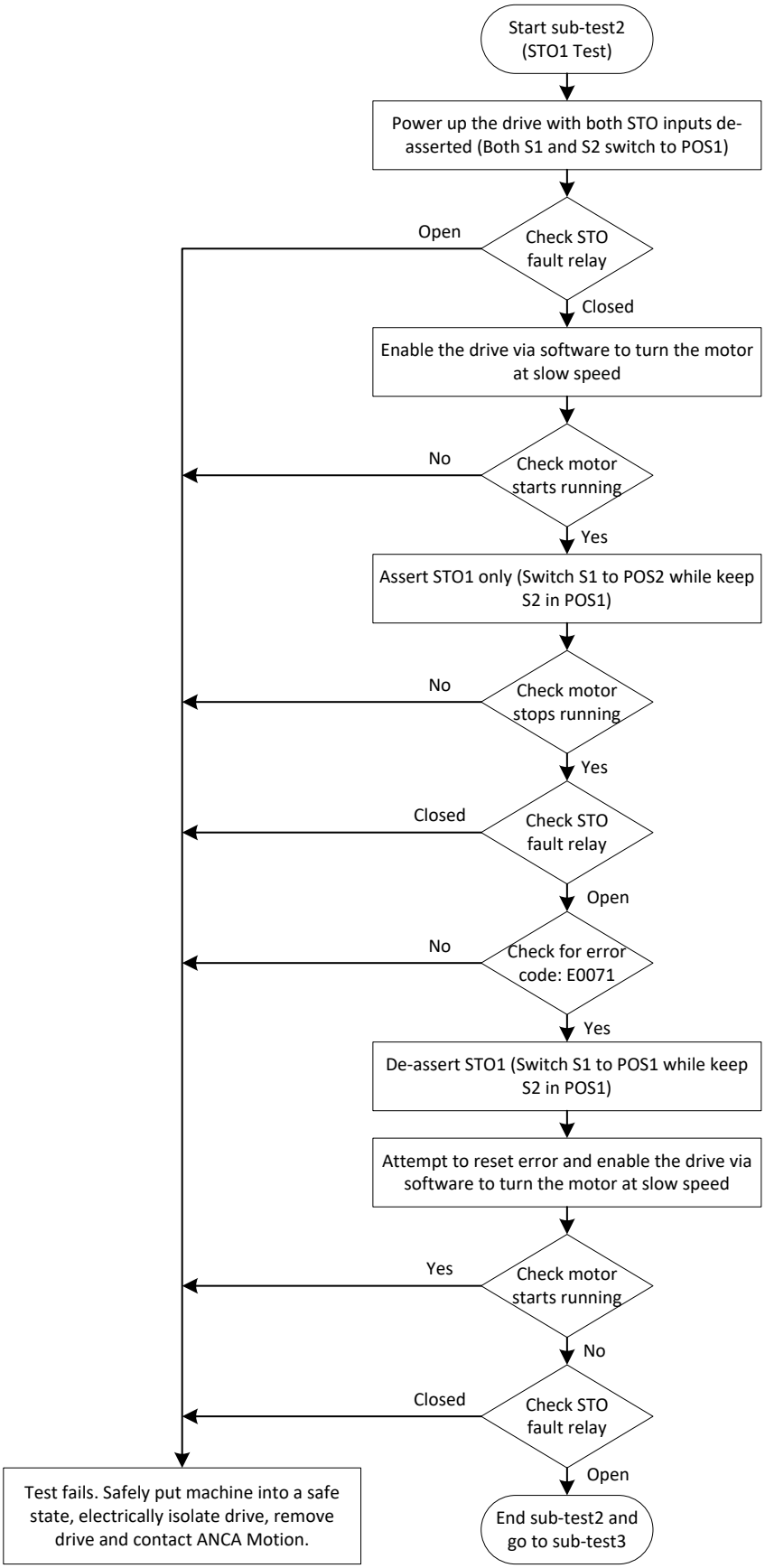


Figure 7-35 STO Sub-Test 2

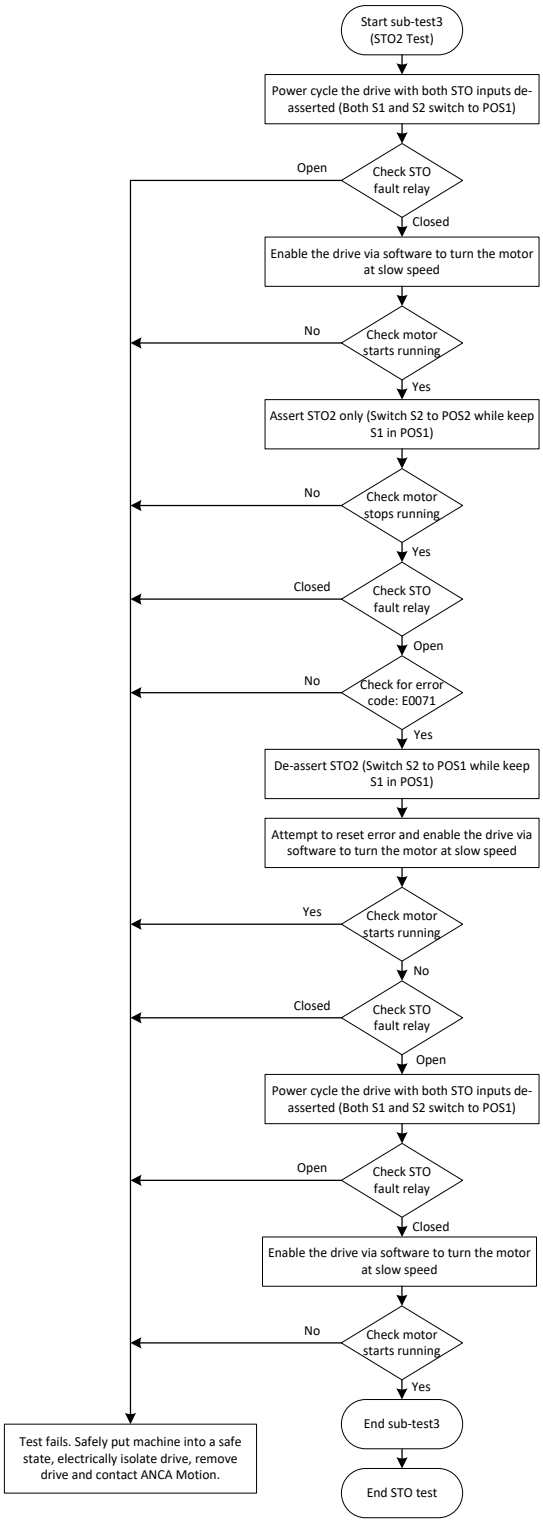


Figure 7-36 STO Sub-Test 3

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 manual.

7.8 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 *6.10* for more information.

7.9 Serial Communication Port

Use of the Serial Communication Port is not supported in the AMD2000 Series servo drives.

7.10 Ethernet Interface

7.10.1 EtherCAT® Protocol

The AMD2000 Series drives support the EtherCAT[1] protocol with Servo Profile over EtherCAT (SoE) 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.

The AMD2000 drive 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.

Figure 7-37 shows a functional block diagram of the EtherCAT circuit.

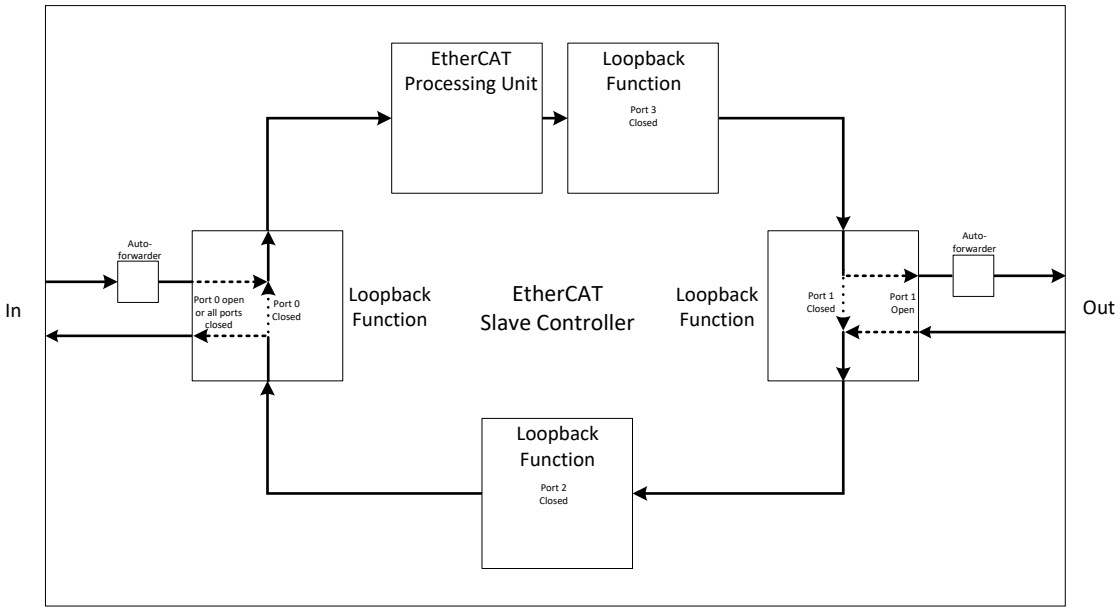


Figure 7-37 EtherCAT Circuit Functional Diagram

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

7.10.2 EtherCAT Network Topologies

Figure 7-38 shows the possible network topologies for connecting an EtherCAT Master device to multiple EtherCAT Slave devices.

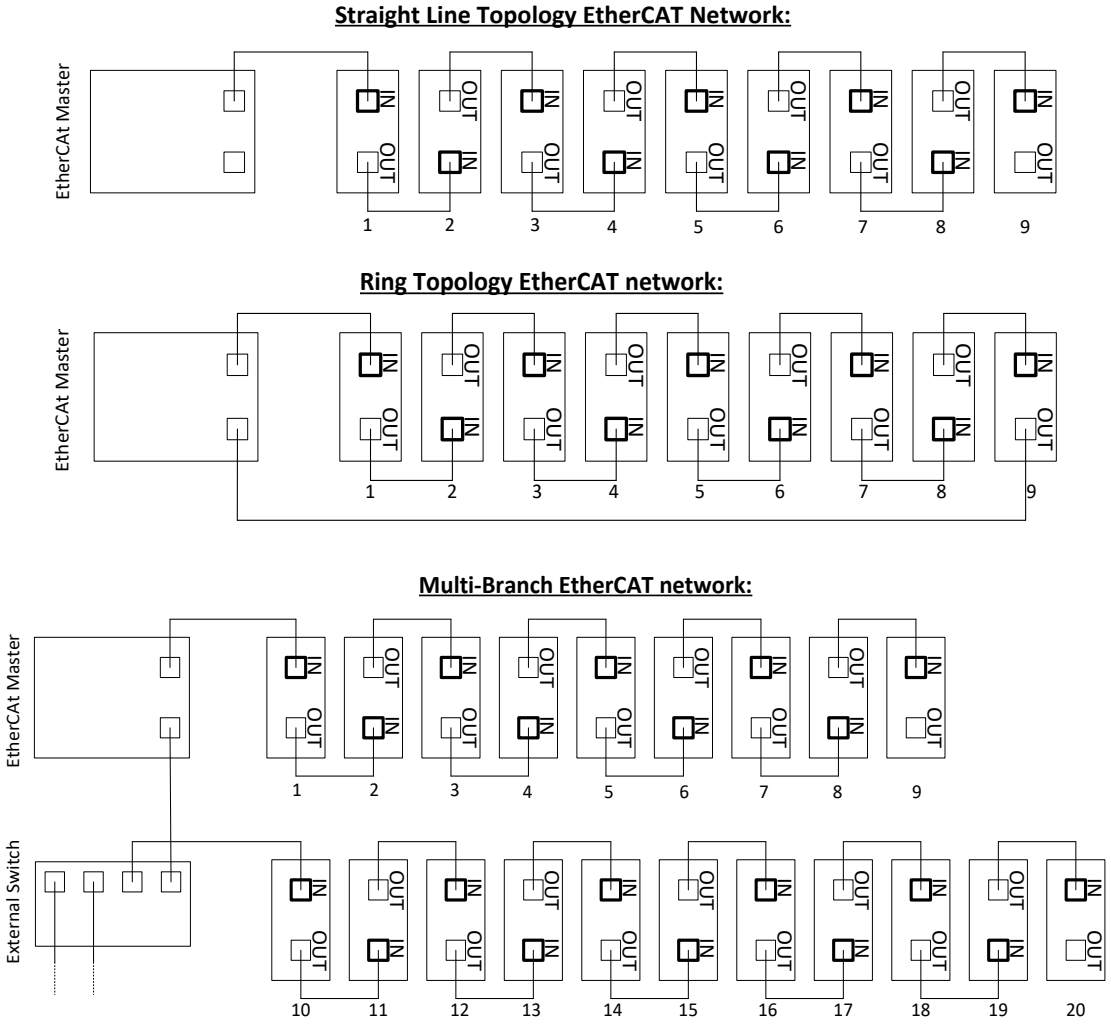


Figure 7-38 EtherCAT Network Topologies

7.10.3 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.

This manual does not cover EtherCAT configuration of the AMD2000 Series servo drive; please refer to *AMD Servo Drive SoE Configuration Guide* for more information.

7.10.4 EtherCAT Connectors and LED Indicators

Section *3.6* shows the location of the EtherCAT ports in the top right-hand corner of the front panel. *Figure 7-39* shows the RJ45 connectors for the EtherCAT input (X1) and output (X2) ports, which incorporate LED indicators for Link/Activity (L/A) and RUN.

	X1	EtherCAT IN
	X2	EtherCAT OUT

Figure 7-39 EtherCAT Connectors

All four LED indicators are green.
The normal (working) state of the RUN indicators is ON.
If the RUN indicator is OFF, the drive is powered down or being initialized.

The normal (working) state of the Link/Activity (L/A) indicator is flickering.
If the L/A indicator is ON the EtherCAT cable is connected, but there is no network activity.
If the L/A indicator is OFF the EtherCAT cable is not connected or the drive is powered down.

7.10.5 EtherCAT Diagnostics

Refer to *AMD Servo Drive SoE Configuration Guide*.

7.10.6 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” as detailed in Table 7-17.

Cable	*Description*	*Conductors*	*Cable Screening*	*Pair Shielding*
Cat 5e (or above)	F/UTP	Twisted Pair (TP)	Foil (F)	Unshielded (U)
	SF/UTP	Twisted Pair (TP)	Braided Screen (S) and Foil (F)	Unshielded (U)

Table 7-13 EtherCAT Cables

Either straight or crossover cables may be used. See Accessories section *11.4.9* for ordering information.

7.11 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

Table 7-14 DIP Buttons

Additional functionality may be available on custom models, refer to *AMD Servo Drive SoE Configuration Guide*.

7.12 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.

The analogue and digital encoder wiring for connector X5 is listed in *Table 7-15*.

Connector	*Pin Number*	*Label*	*Analogue Encoder[1]*	*Digital Incremental Encoder[2]*
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	9 Vdc	-	-
	14	5 Vdc	5 Vdc	5 Vdc
	15	GND	GND	GND

Table 7-15 Analogue and Digital Encoder Connections

7.12.1 Analogue Encoder Interface

Figure 7-40 shows an idealized diagram of the analogue encoder interface.

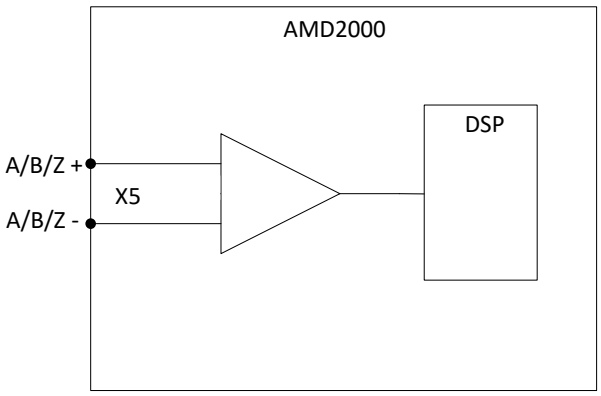


Figure 7-40 Idealized Analogue Encoder Circuit

[1] 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 *AMD Servo Drive SoE Configuration Guide* for more information.
[2] Encoder channel 2 is designed to support digital incremental encoders only.

7.12.2 Digital Encoder Interface

Figure 7-41 shows an idealized diagram of the digital encoder interface.

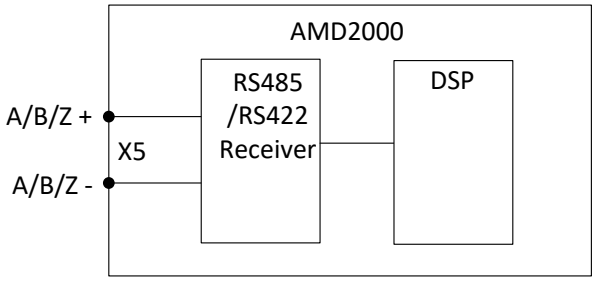


Figure 7-41 Idealized Digital Encoder Circuit

7.12.3 Encoder Cables

A variety of analogue and digital encoder cables, Hiperface DSL cables, and an encoder splitter cable are available. Refer to Accessories section *11.3* for ordering information.

8 Installation Checklist

8.1 What this Chapter Contains

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

8.2 Checklist

- ❒ The installation location meets the requirements of sections *4.3.2* and *10.5.3*.
- ❒ An adequately sized protective earth wire is installed between the drive and the installation Earth Bar.
- ❒ The required ventilation clearances around the drive are according to section *4.3.3*.
- ❒ An adequately sized protective earth wire is installed between the drive and the motor.
- ❒ Each protective earth conductor is securely connected to the appropriate terminal.
- ❒ The supply voltage does not exceed 264 Vrms between L1, L2 and L3.
- ❒ The input power cable is connected to the appropriate terminals and the connections are secure.
- ❒ 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 connections are secure.
- ❒ The brake resistor cable (if applicable) has been securely connected to the appropriate terminals.
- ❒ 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 between the drive and the motor (if required by the application).
- ❒ All low voltage control cables have been installed and the connections are secure.
- ❒ There is no dust or foreign objects inside the drive after installation (e.g. due to cutting 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 conducted on the entire machine, potential hazards have been identified, and appropriate safety controls and procedures have been implemented for safe operation.
- ❒ Regeneration energy has been assessed and an external resistor has been connected if required.
- ❒ The encoder cable has been checked for wiring faults.
- ❒ The total load of all digital outputs does not exceed 500mA.
- ❒ The STO Commissioning Test has been completed and PASSED following the instructions in section *7.7.8* or if STO is not required, then the STO function has been disabled as detailed in section *7.7.5.5*.

9 Start-up

Please refer to *AMD Servo Drive SoE Configuration Guide* for configuration, tuning and diagnostics information.

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	Yes, via EtherCAT (SoE) & Pulse Input
Velocity Control	Yes, via EtherCAT (SoE) & Analogue Voltage Input
Current/Torque Control	Yes, via EtherCAT (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[1]
Over-travel limit exceeded	Yes

[1]Refer to *AMD Servo Drive SoE Configuration Guide* for adjustment.

Attribute	*Qualification*
### *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 µs
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	3 V (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

Attribute	*Qualification*
10.3.5 Differential Digital Encoder Output	
Voltage Rating	5 V
Number of Outputs	3 x line driver (6 wires)
Min. Output High Voltage Single-Ended W.R.T GND	2.5 V @ 20 mA
Max. 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: 5 V Line Drive
Supported Encoders	Analogue Incremental Sin/Cos (1 Vpp) Digital Incremental (5 V)

Attribute	*Qualification*
10.3.9 Encoder Channel 1	
Interface Type	Analogue 1 Vpp
Supported Inputs	Sin, Cos, Ref (1 Vpp)
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 Analogue Encoder Input	
Supported Channels	1
Interface Type	Analogue 1 Vpp
Supported Inputs	Sin, Cos, Ref (1 Vpp)
1Vpp Commutation Track	Not Supported
1Vpp Terminating Resistance	120 Ω
1Vpp Full Scale Differential Input Voltage	1.6 Vpp
1Vpp Bandwidth	200 kHz
10.3.11 Digital Encoder Input Channel 2	
Supported Channels	1
Interface Type	RS422
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	1 Mhz
10.3.12 Encoder Supply	
Nominal Voltage	5 Vdc ±1% regulated supply 9 Vdc ±2.5% regulated supply
Maximum Current	400 mA (5 Vdc) 500 mA (9 Vdc)
Short Circuit Protection	Yes

Attribute	*Qualification*
10.3.13 Ethernet Interface	
Protocol	EtherCAT
Baud Rate	100 Mb/s
Drive Profile Definition	SoE
Connector	Ethernet RJ-45
10.3.14 Drive Display	
Indicator	5 x 7-segment LED
Operator Interfacing	4 x DIP buttons

10.4 Electrical Specifications

Attribute	*Symbol*	*Catalogue Number*		
		D2103	*D2109*	*D2015*
		Qualification		
10.4.1 Power Supply Section				
Drive Input voltage	$U_{LN-(1\Phi)}$ $U_{LL-(3\Phi)}$	100~240 Vac 200~240 Vac		
Voltage fluctuation	U_{δ}	± 10%		
Input frequency	f_{LN}	50 / 60 Hz		
Maximum input voltage to Protective Earth	$U_{L1,L2,L3-PE}$	264 Vac		
Auxiliary input current	I_{LN}	500 mA		
Built-in Soft Start Relay		Internal		
10.4.2 Digital Servo Drive				
DC voltage	U_{DC}	1.404 x $U_{LN-(1\Phi - 3\Phi)}$		
Max. output voltage	U_{aN1}	0.90 x $U_{LN-(1\Phi - 3\Phi)}$		
Continuous output current	I_{aN}	3 Arms	9 Arms	15 Arms
One-minute overload capability	I_{aM}	110%		
Peak repetitive overload current	I_p	6 Arms	12.9 Arms	30 Arms
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[1]		400 W	1.5 kW	5.1 kW
Max. Output frequency (at nominal ULN)	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.

[1] Specific power de-rating curves can be found in section *10.9*.

Attribute	*Catalogue Number*		
	D2103	*D2109*	*D2015*
	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	3 A at U_{DC}	9 A at U_{DC}	9 A at U_{DC}
Internal Brake Resistor	40 Watts	60 Watts	60 Watts
External Brake Resistor	Optional		

10.5 Environmental Specifications

Attribute	*Catalogue Number*		
	D2103	*D2109*	*D2015*
	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 9.8 m/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[1]		
Maximum Ambient Temperature[2]	+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.			

[1] 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.

[2] De-rating is applied to the D2103 at some temperatures below 55°C, refer to section *10.9*.

Attribute	*Catalogue Number*		
	D2103	*D2109*	*D2015*
	Qualification		
10.5.4 Physical Characteristics			
Degree of Protection	IP20 in accordance with EN60529[1]		
Mounting position in Operation	Vertical		
Device Weight	1.25 kg	2.10 kg	2.80 kg
Height (mm)	206	182	261
Width (mm)	43	60	60
Depth (mm)	189	189	189
10.5.5 Cooling			
Fan Cooled	No	Yes	Yes
Heat generation @ full rated continuous current[2]	31 W	80 W	128 W

[1] 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.
[2] This amount of heat energy needs to be removed from the equipment cabinet to prevent overheating.

10.6 Accessory Specifications

Attribute	*Qualification*
10.6.1 I/O Interface Module	
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
10.6.2 Motor Thermistor Isolation Module	
Number of Temperature Sensor Inputs	1
Number of Analogue Outputs	1
Output Voltage @150^{0}C	+11.4 V
Output Current @150^{0}C	0.4 mA
Short circuit protection to 24V	No
Short circuit protection to GND	Yes
Isolated	Yes
Supported Temperature Sensor	KTY84-130
10.6.3 Power Supply Soft Start Module	
Maximum Connected Drives[1]	4 at 100 Vac 8 at 240 Vac
Maximum Operating Voltage	264 Vac 50 / 60 Hz
Maximum Operating Continuous Current	2 A
Power Consumption	3.1 W
Limiting NTC Resistance	0.93 Ω
Connector	Spring-cage terminal block, 2-position
Outside Dimensions	H=94mm x W=36mm x D=58mm
Product Colour	Light Grey
Mounting Type	DIN rail, 35 mm (W) x 7.5 or 15 mm (H) (EN 60715 TS35)
Enclosure Material	Polycarbonate, flame-retardant (UL 94-V0)
Ingress Protection	IP20 (IEC 60529)
Operating Temperature Range	0 to +55 °C
Maximum installation/operating altitude (with respect to mean sea level)	1,000 m

[1] There are restrictions on the Soft Start Module's I/O and encoder current draw. Refer to *Table 6-5*.

10.7 Dimension Drawings

10.7.1 D2103 Drive Physical Dimensions

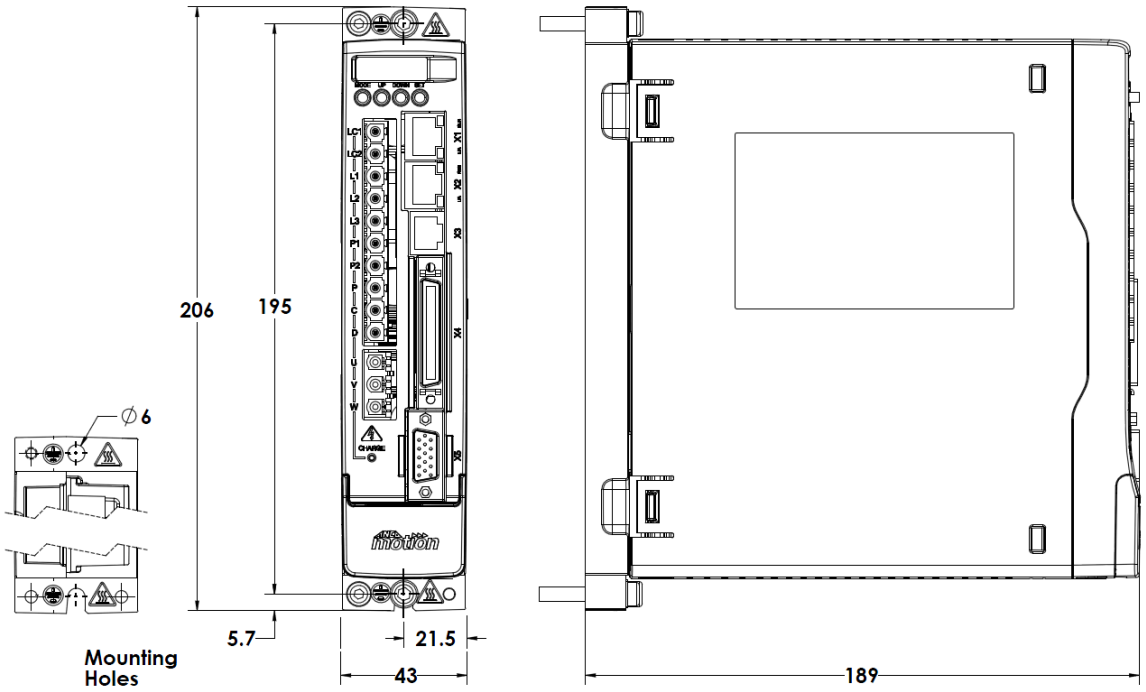


Figure 10-1 D2103 Drive Dimensions (mm)

10.7.2 D2109 Drive Physical Dimensions

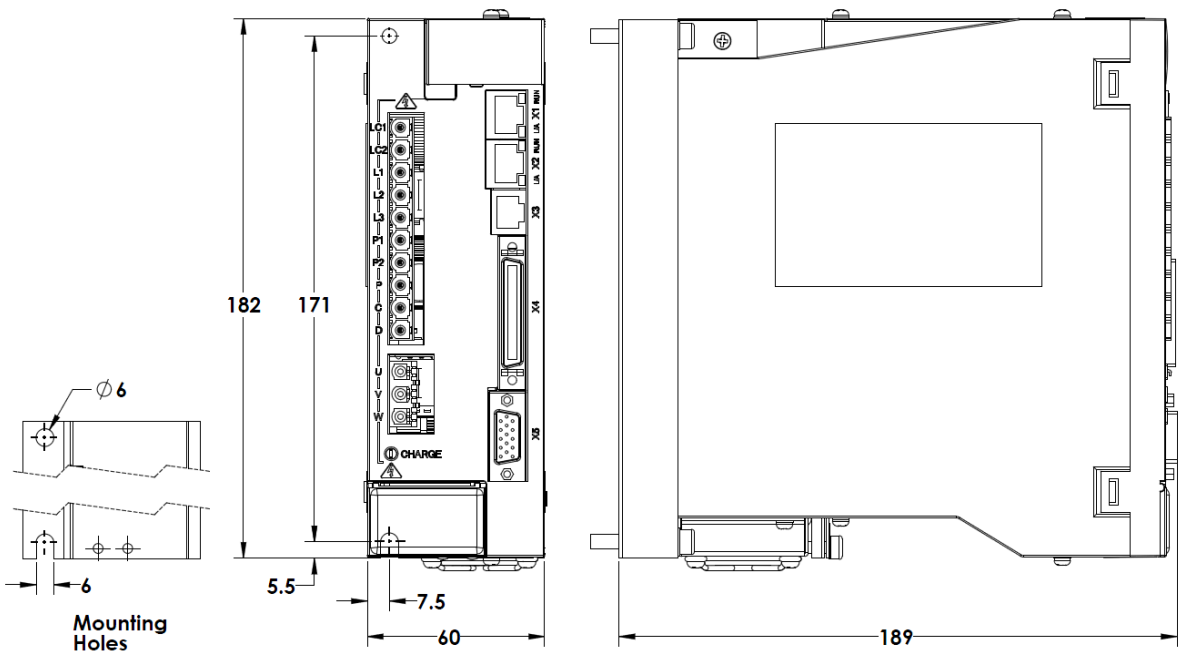


Figure 10-2 D2109 Drive Dimensions (mm)

10.7.3 D2015 Drive Physical Dimensions

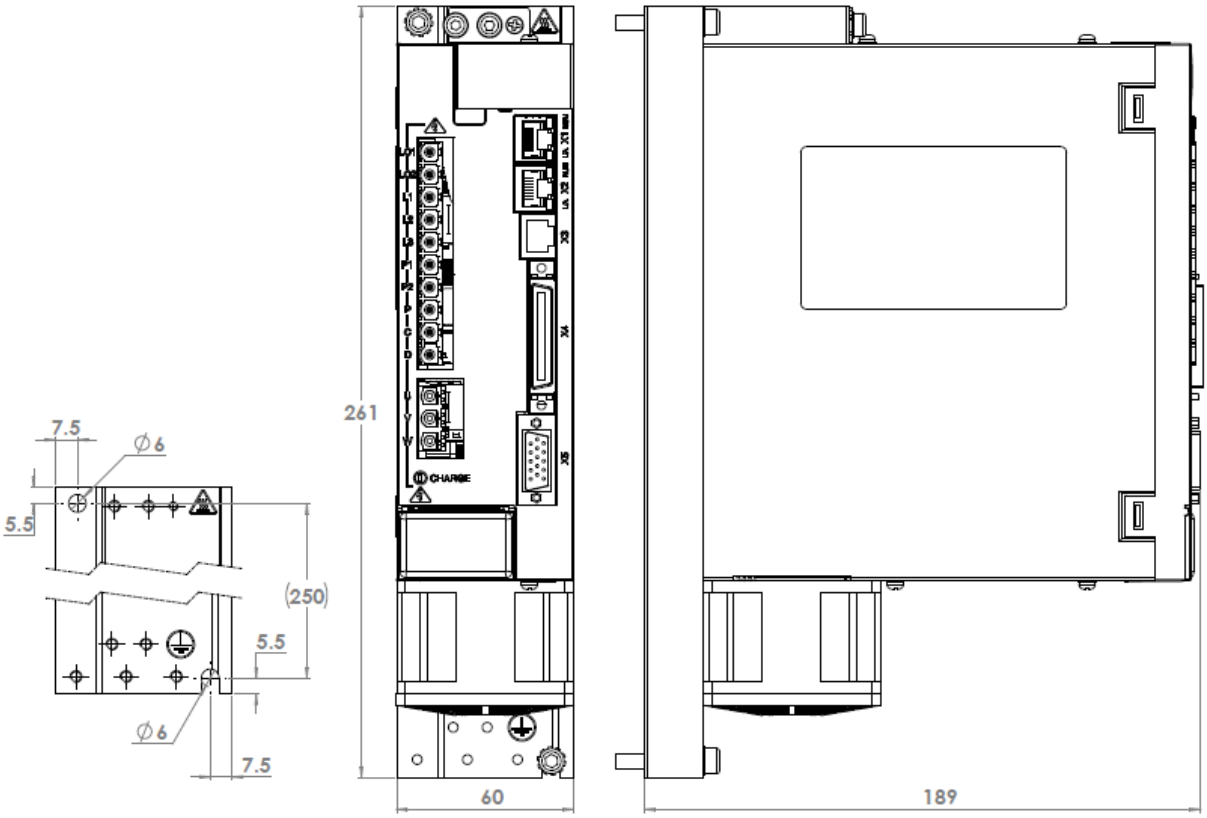


Figure 10-3 D2015 Drive Dimensions (mm)

10.7.4 Soft Start Module Physical Dimensions

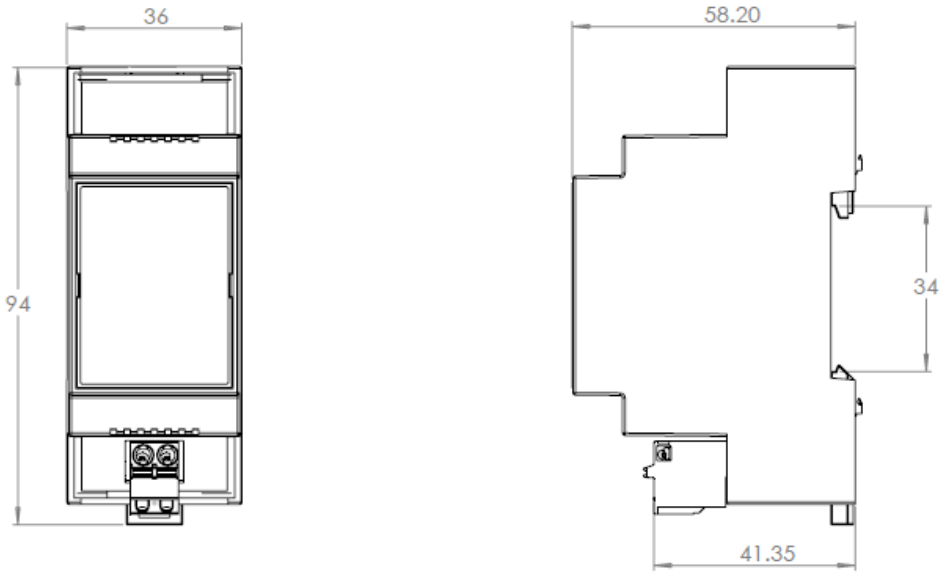


Figure 10-4 Soft Start Module Dimensions (mm)

10.8 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. If an external power supply is used it must be of the Separated Extra Low Voltage (SELV) type and approved to IEC 61950. Note, 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.

10.9 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 section *6.5*. There is no temperature de-rating specified unless explicitly demonstrated.

10.9.1 D2103 De-rating

10.9.1.1 1-Phase

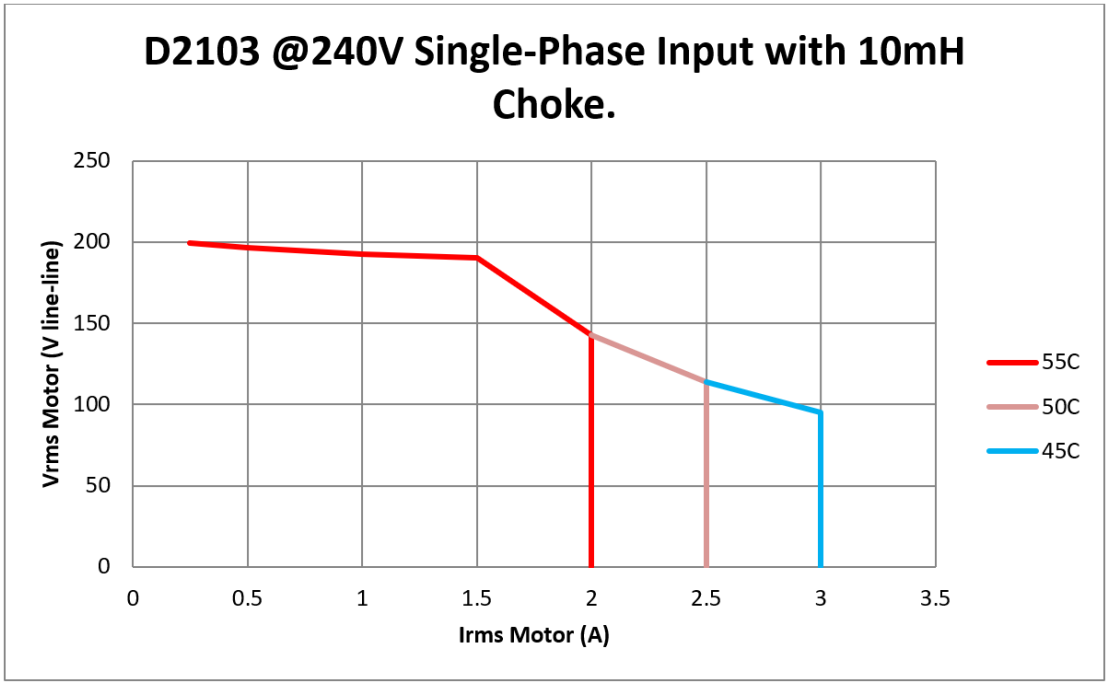


Figure 10-5 D2103 De-rating 1-Phase 240V

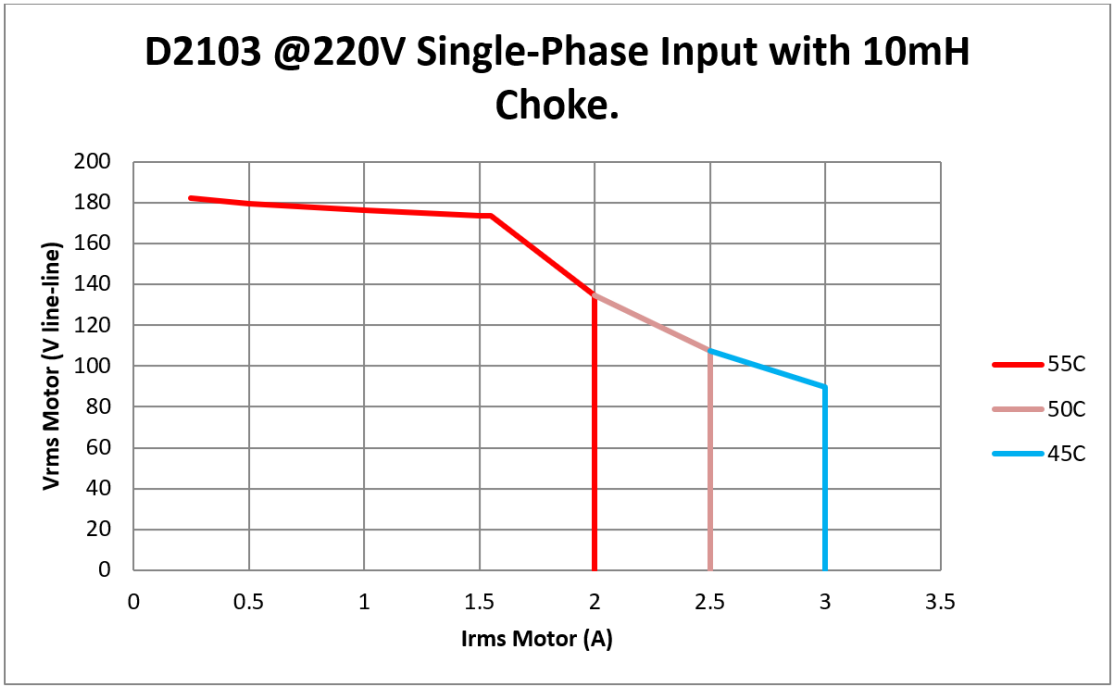


Figure 10-6 D2103 De-rating 1-Phase 220V

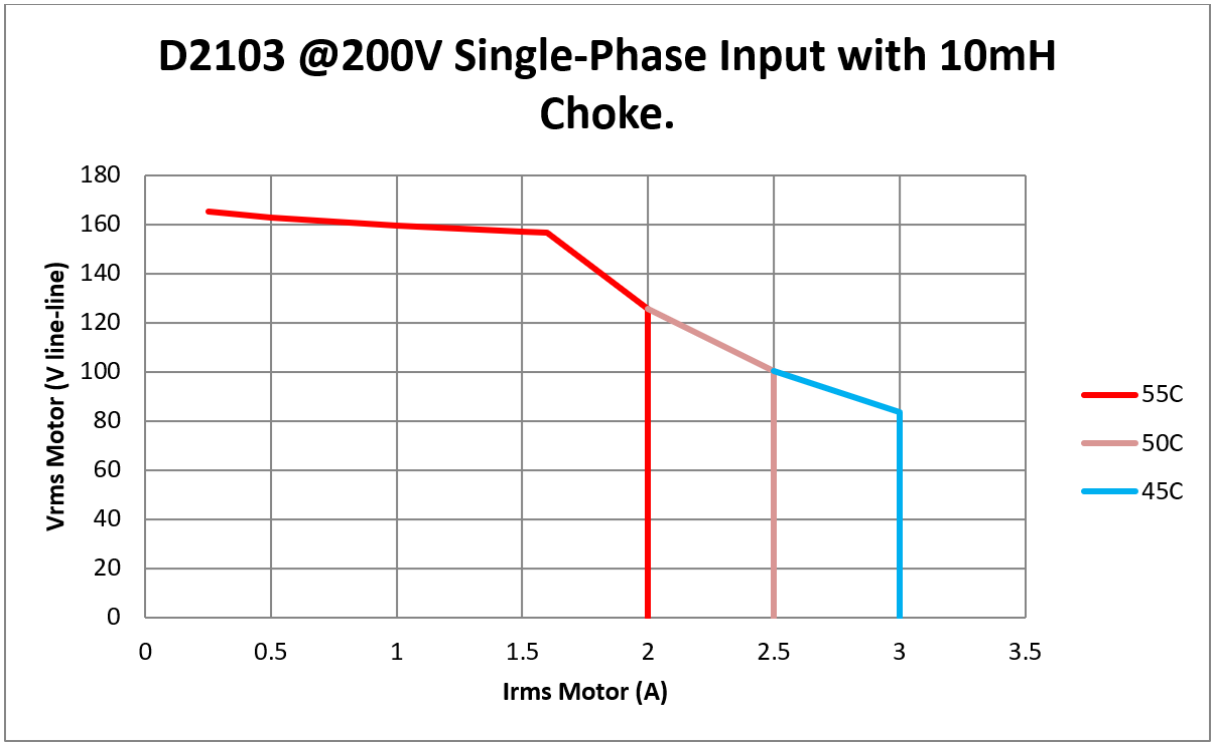


Figure 10-7 D2103 De-rating 1-Phase 200V

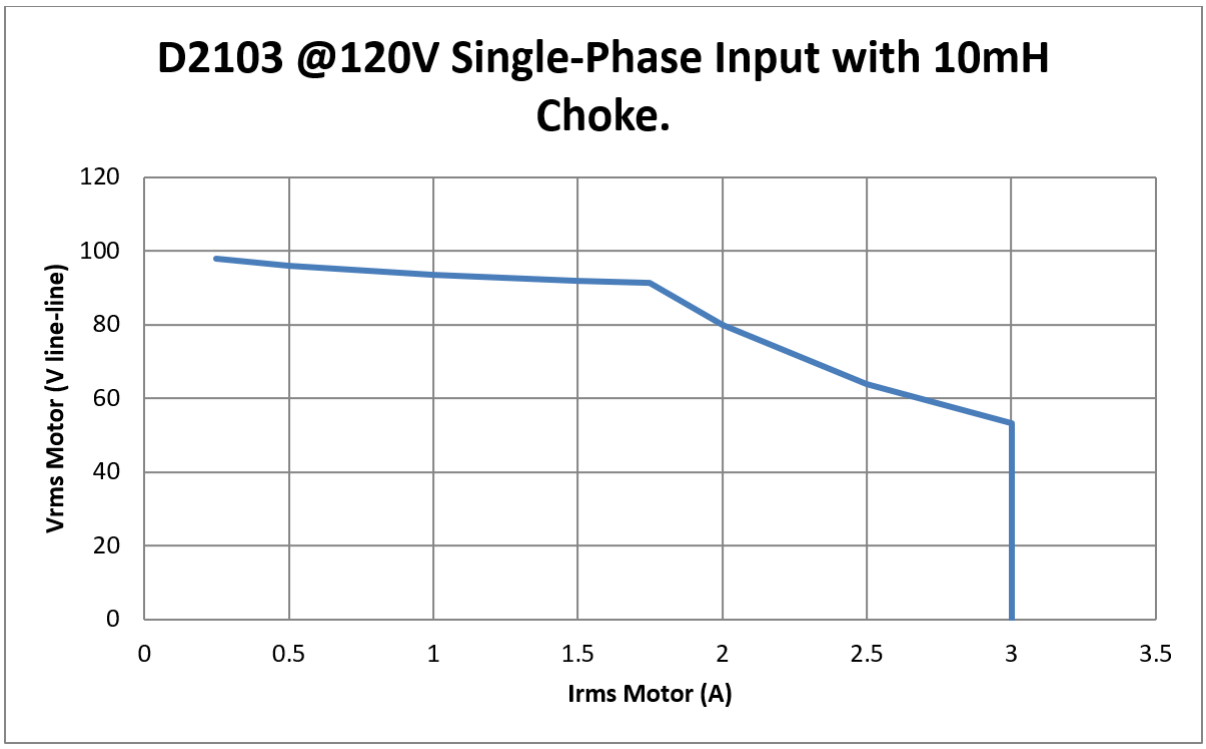


Figure 10-8 D2103 De-rating 1-Phase 120V

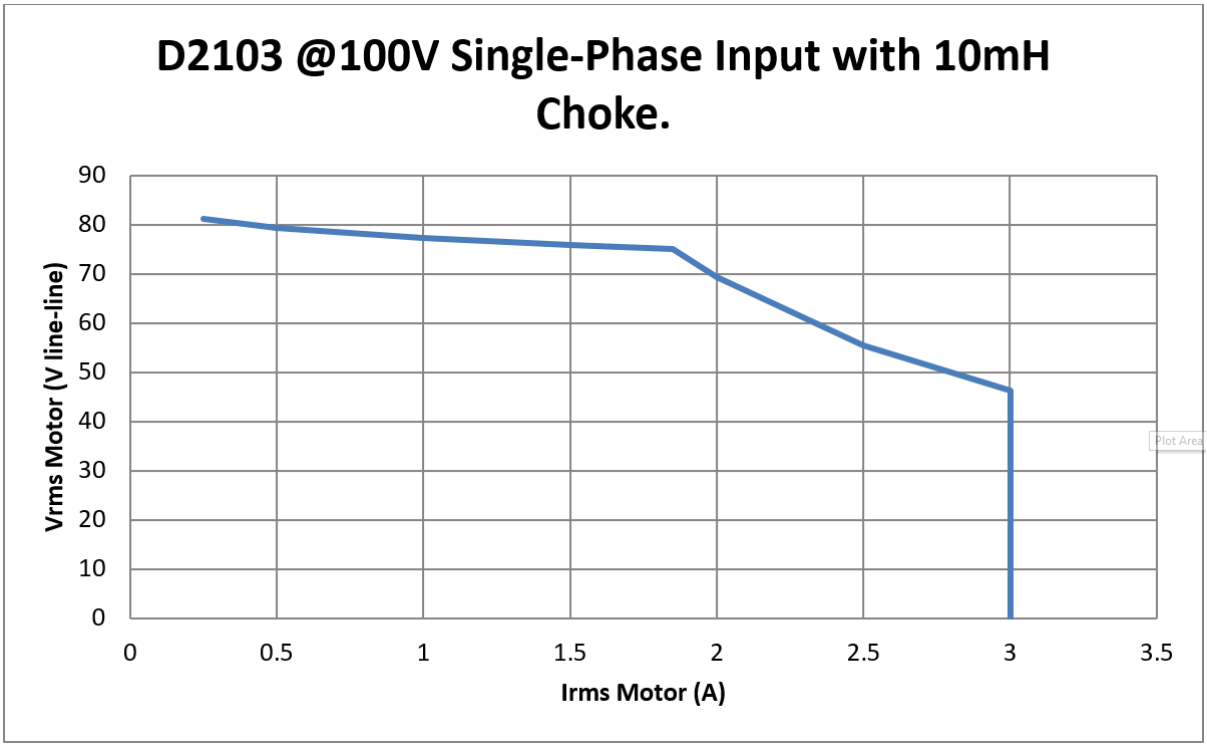


Figure 10-9 D2103 De-rating 1-Phase 100V

10.9.1.2 3-Phase

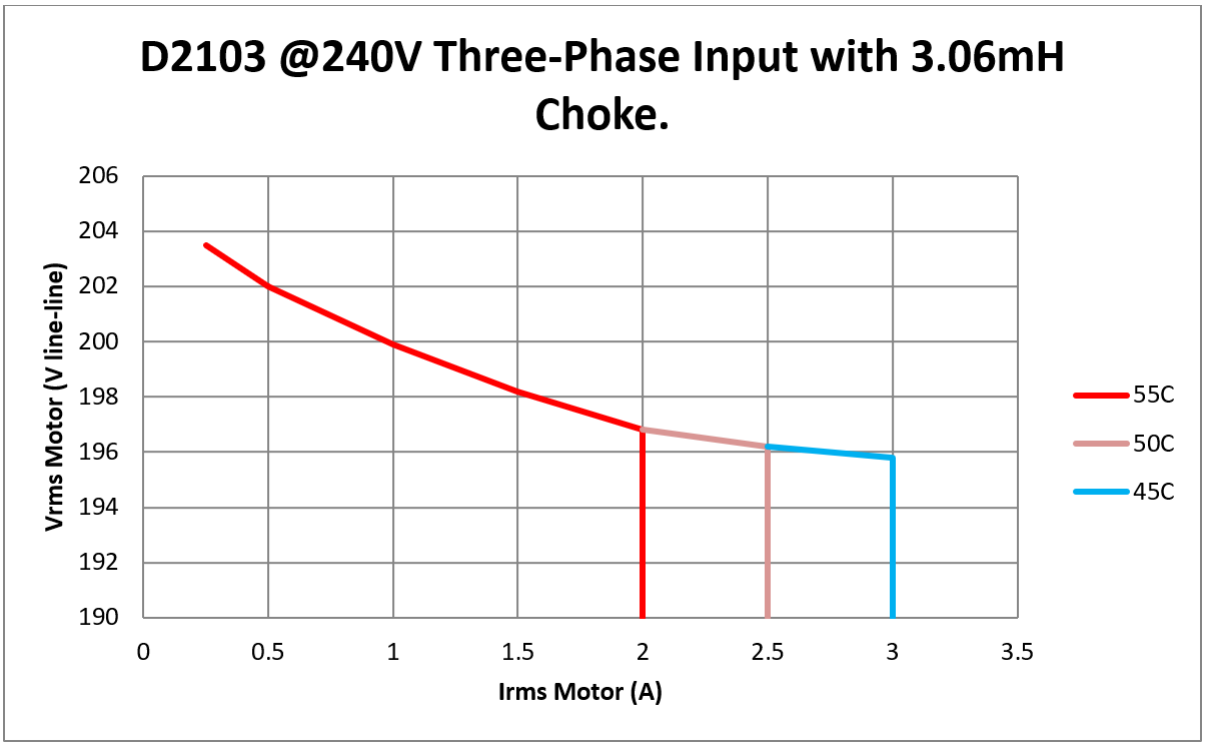


Figure 10-10 D2103 De-rating 3-Phase 240V

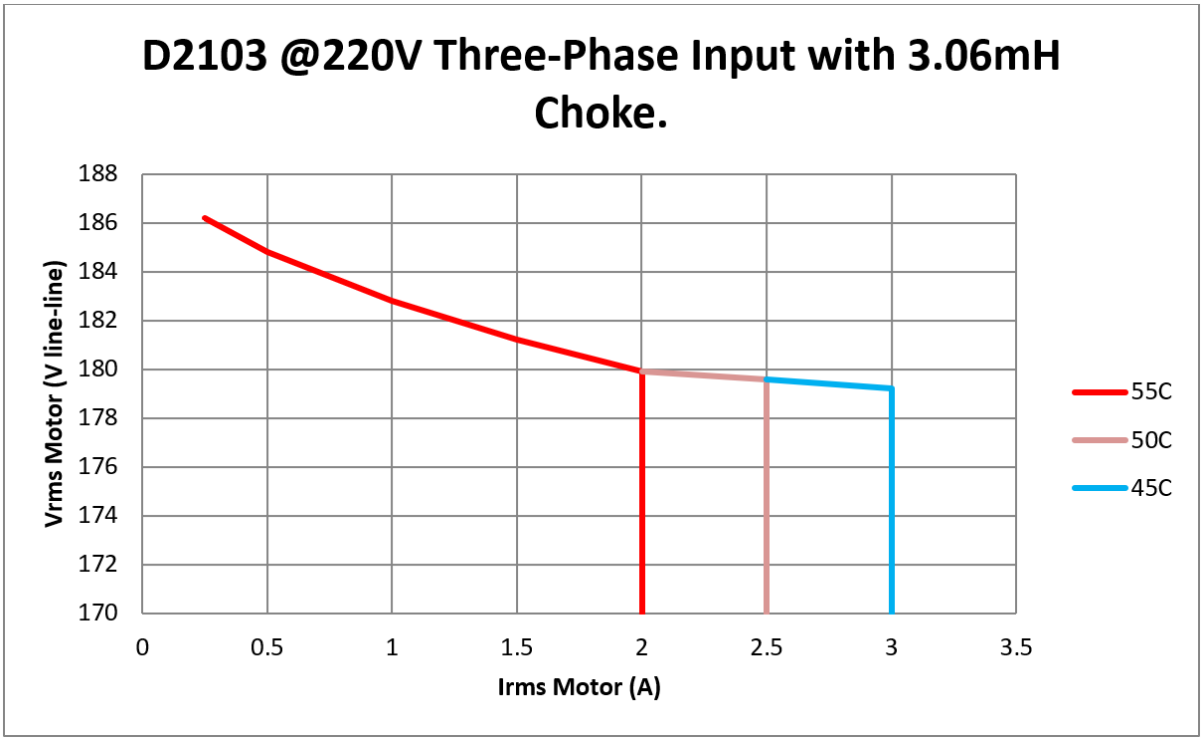


Figure 10-11 D2103 De-rating 3-Phase 220V

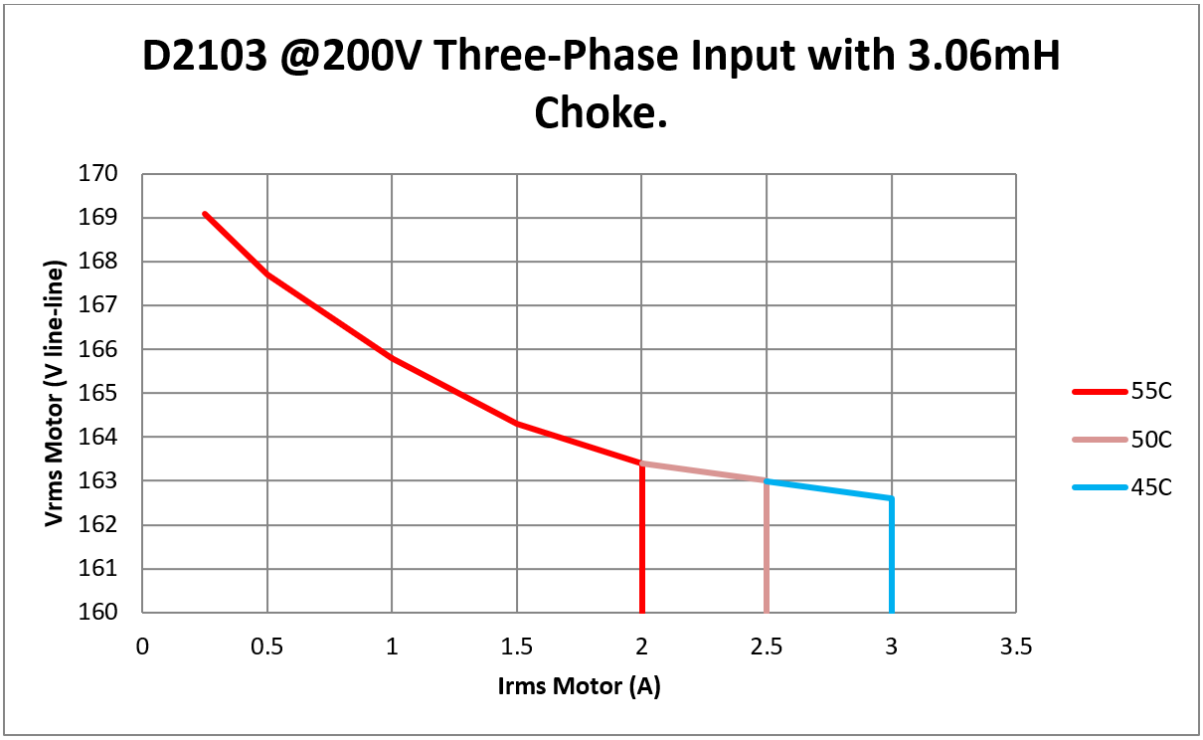


Figure 10-12 D2103 De-rating 3-Phase 200V

10.9.2 D2109 De-rating

10.9.2.1 1-Phase

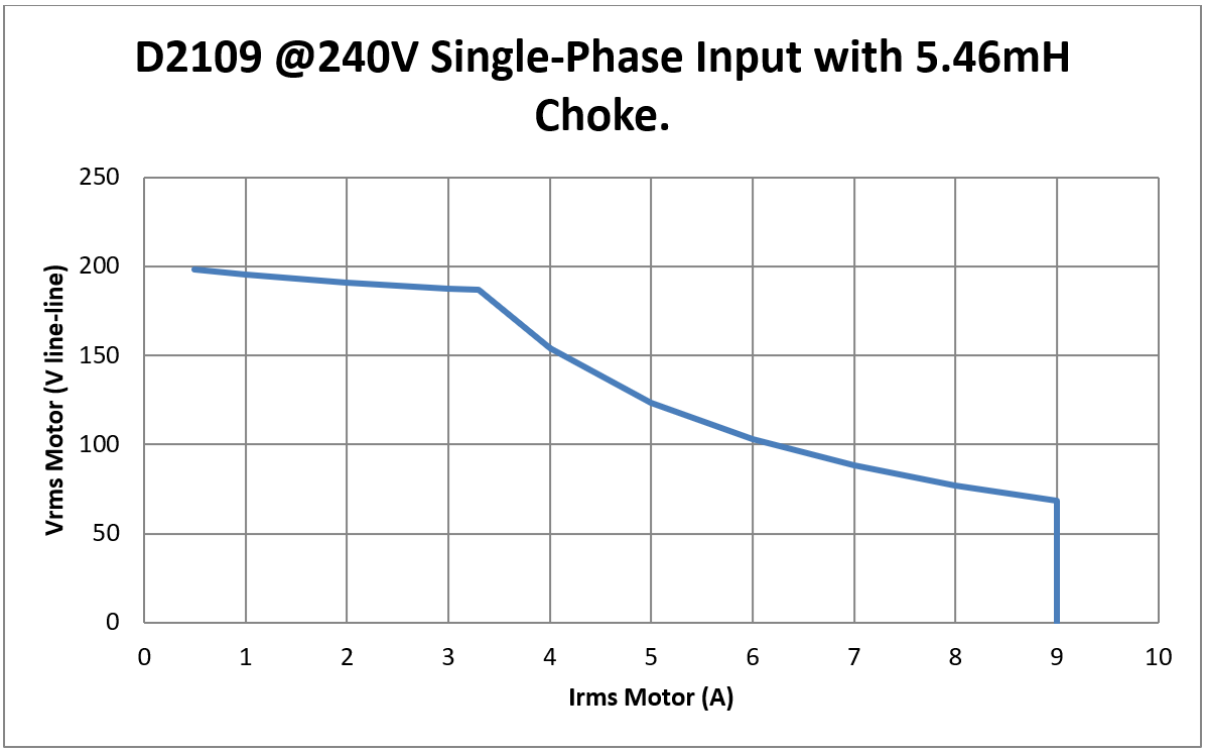


Figure 10-13 D2109 De-rating 1-Phase 240V

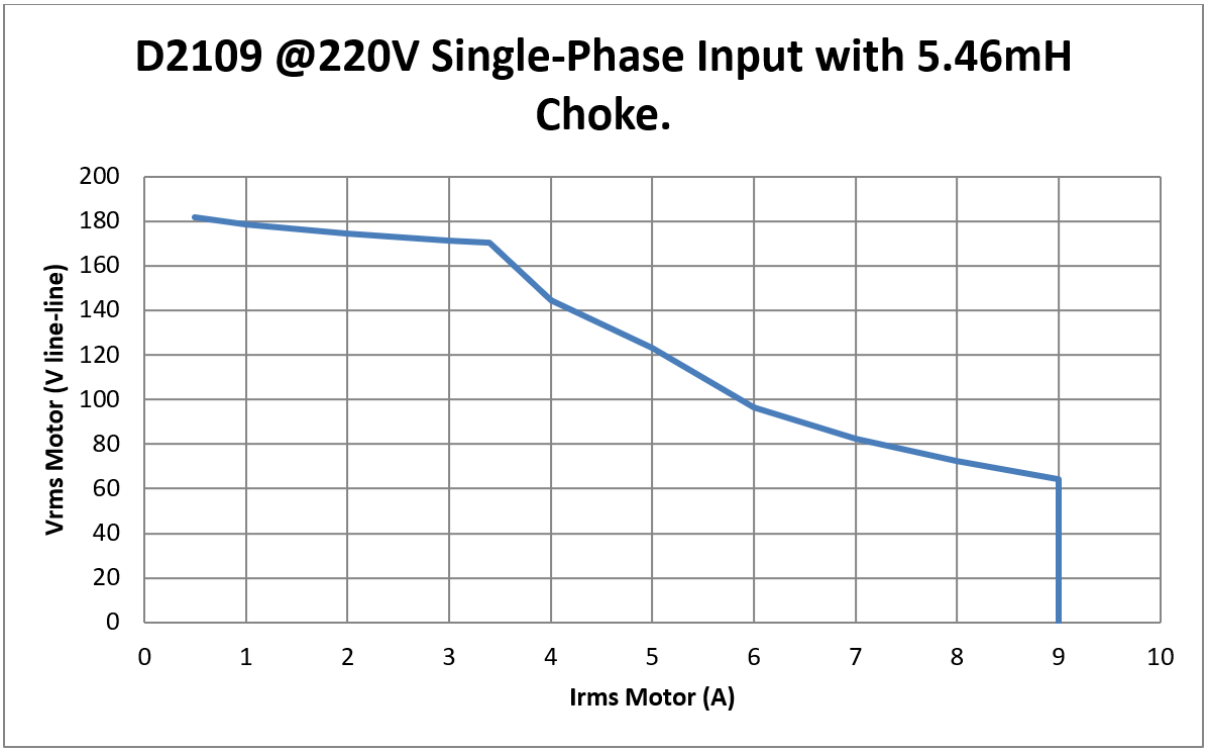


Figure 10-14 D2109 De-rating 1-Phase 220V

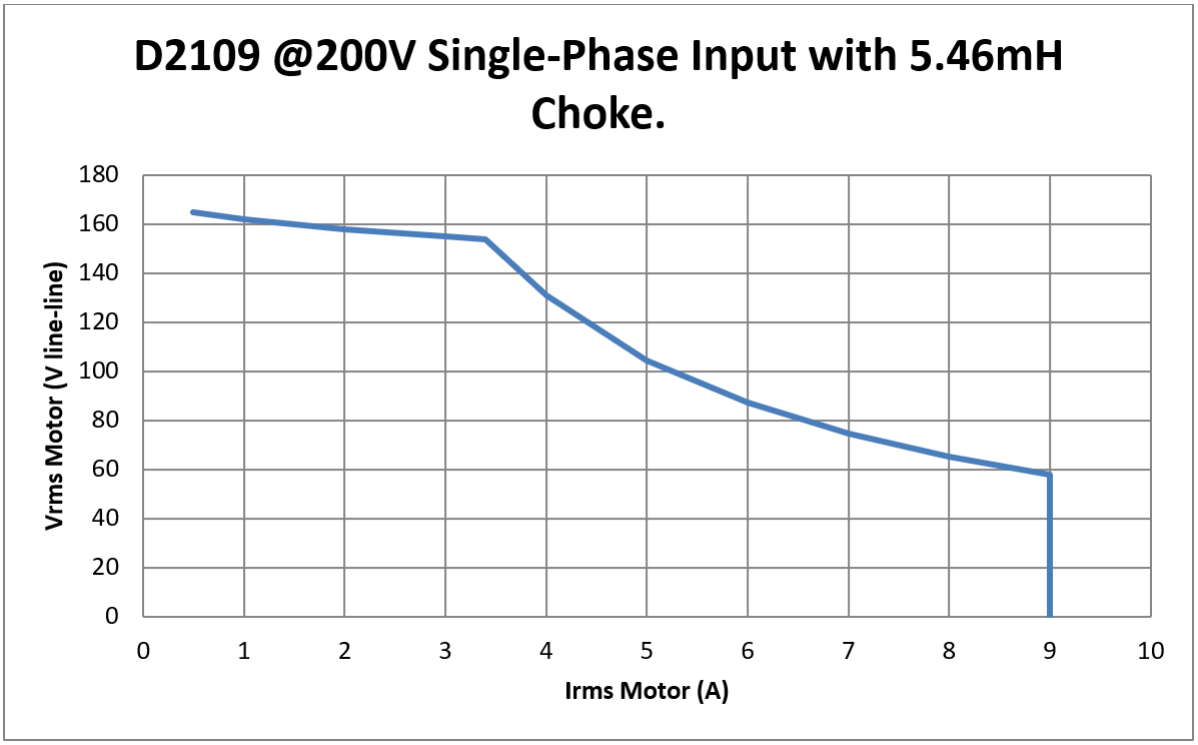


Figure 10-15 D2109 De-rating 1-Phase 200V

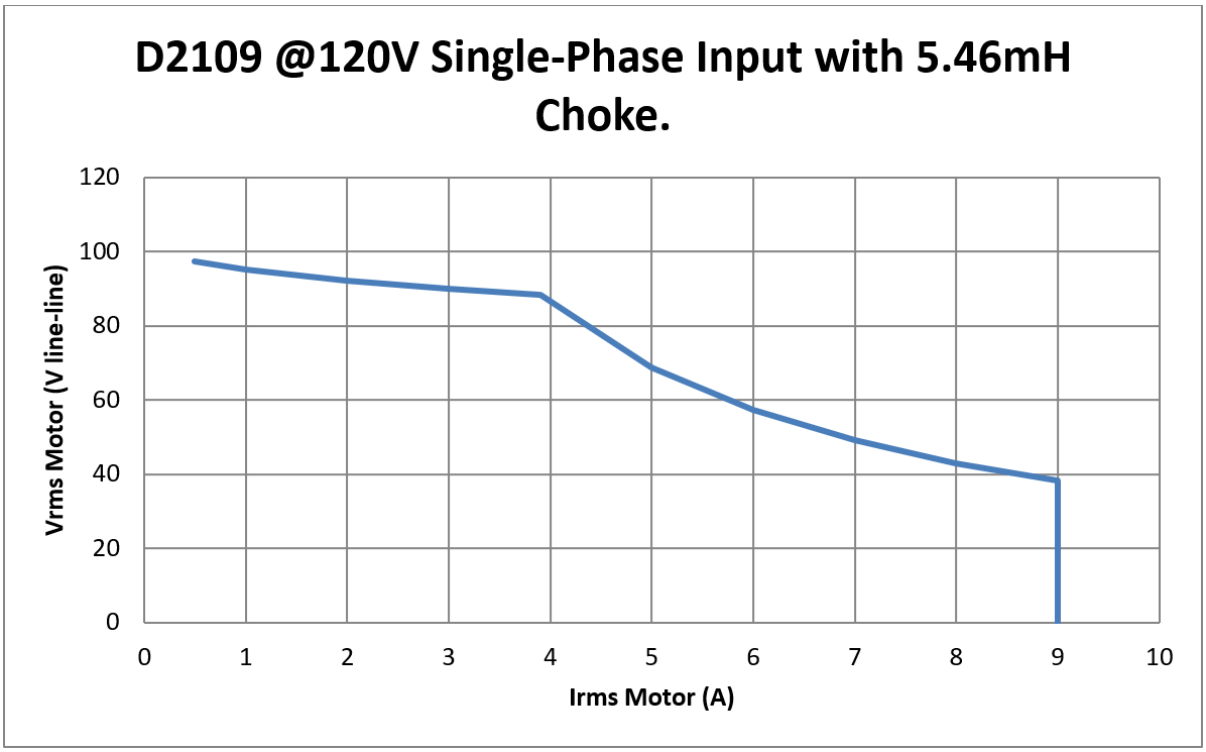


Figure 10-16 D2109 De-rating 1-Phase 120V

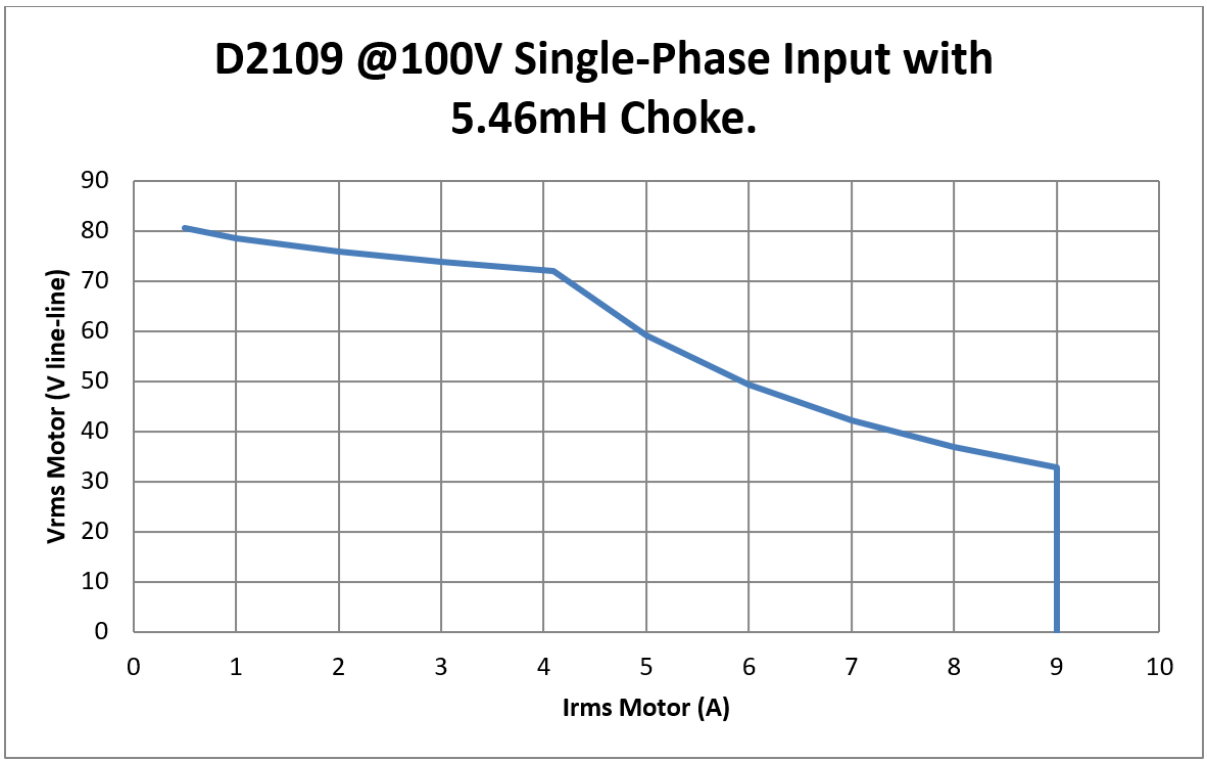


Figure 10-17 D2109 De-rating 1-Phase 100V

10.9.2.2 3-Phase

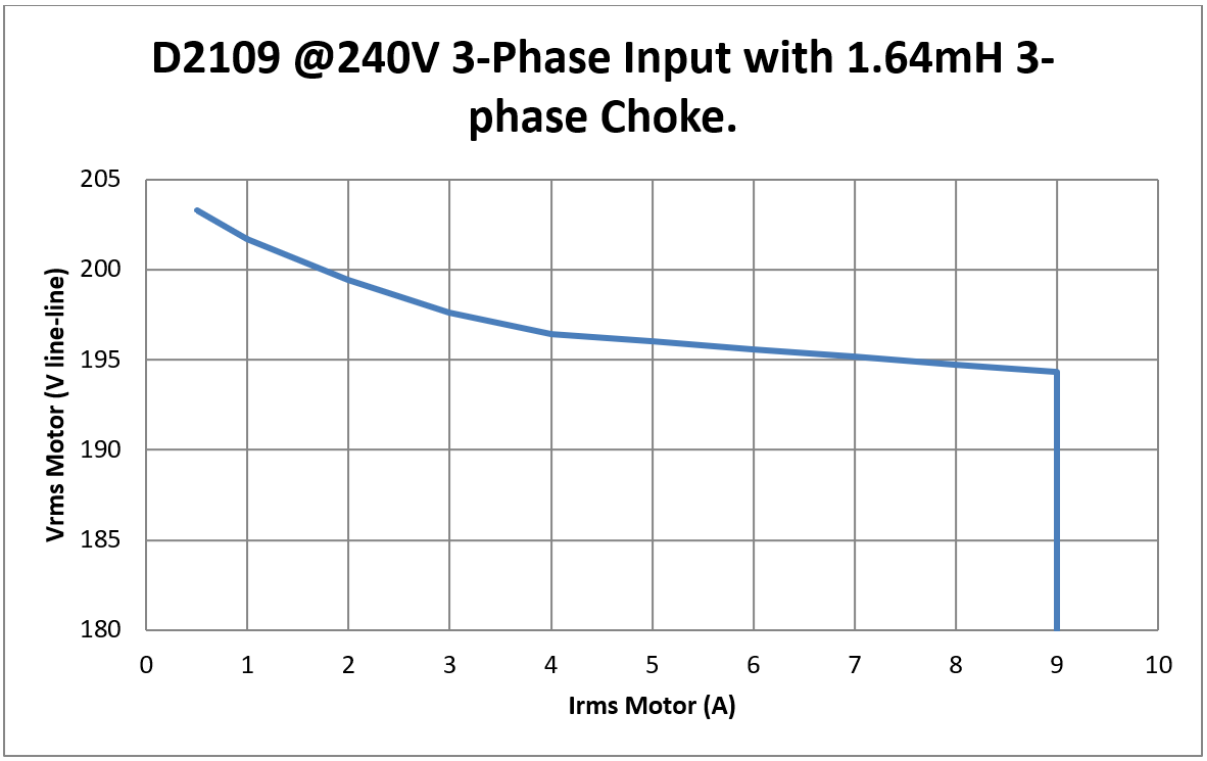


Figure 10-18 D2109 De-rating 3-Phase 240V

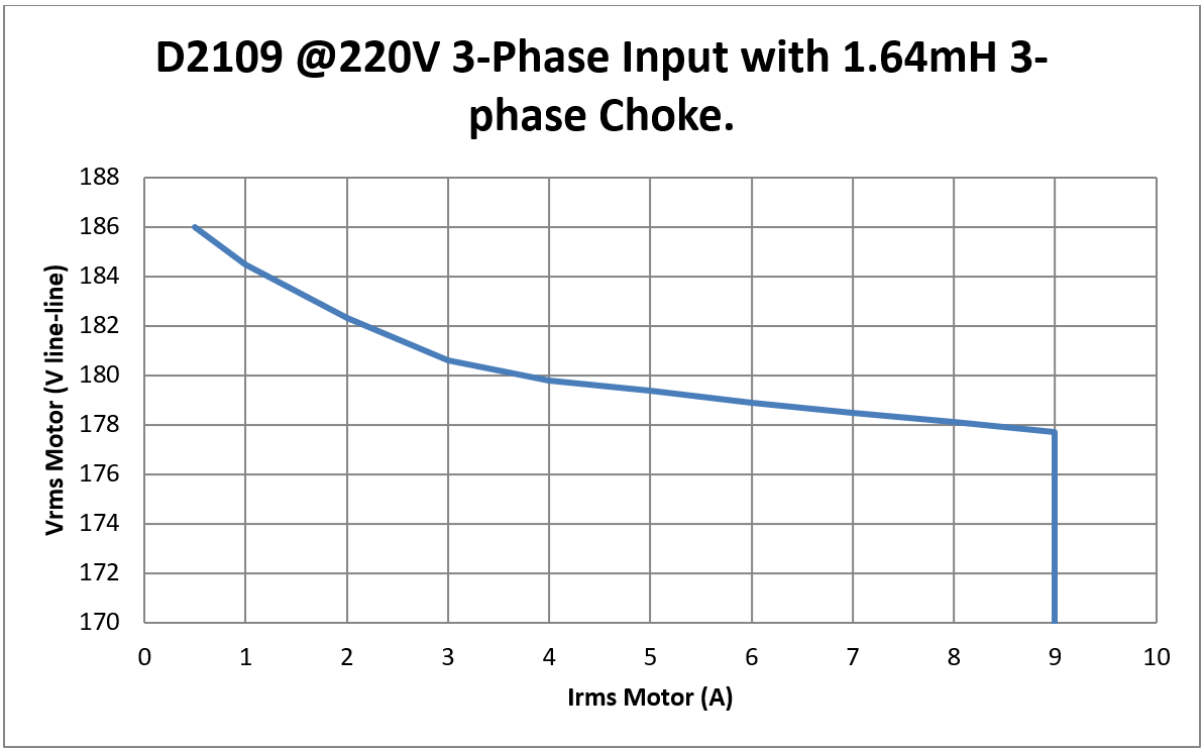


Figure 10-19 D2109 De-rating 3-Phase 220V

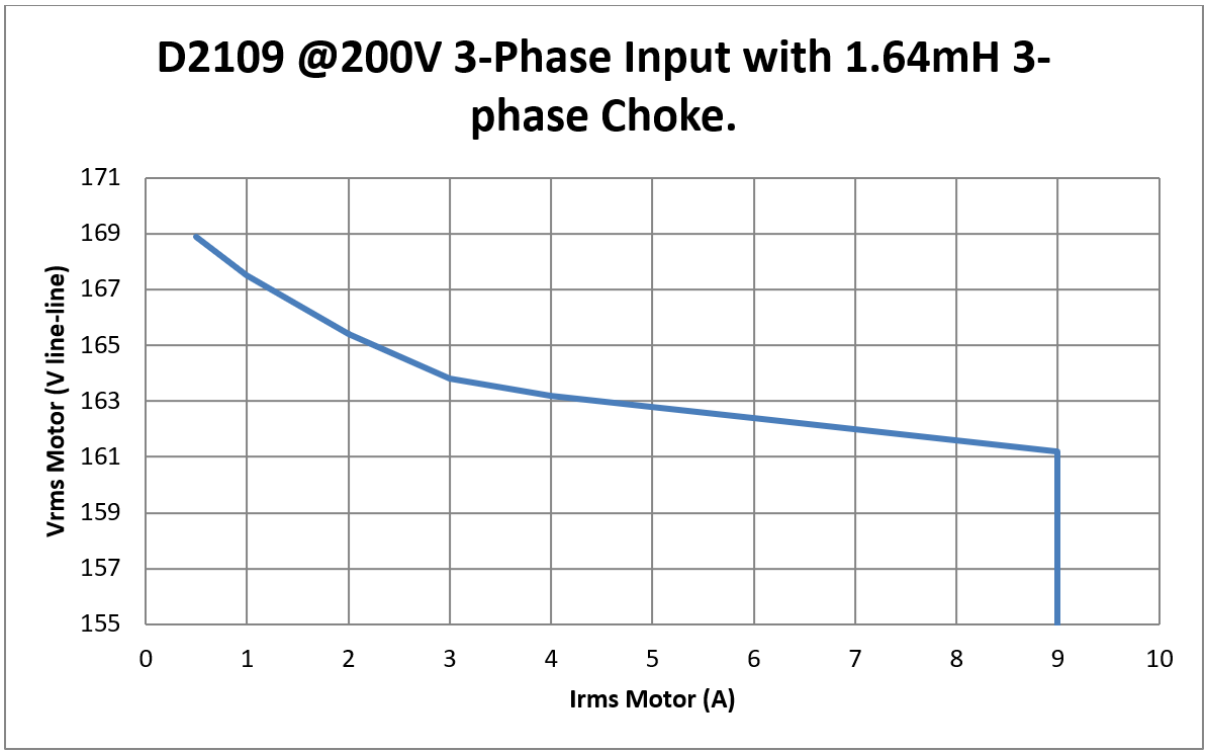


Figure 10-20 D2109 De-rating 3-Phase 200V

10.9.3 D2015 De-rating

10.9.3.1 1-Phase

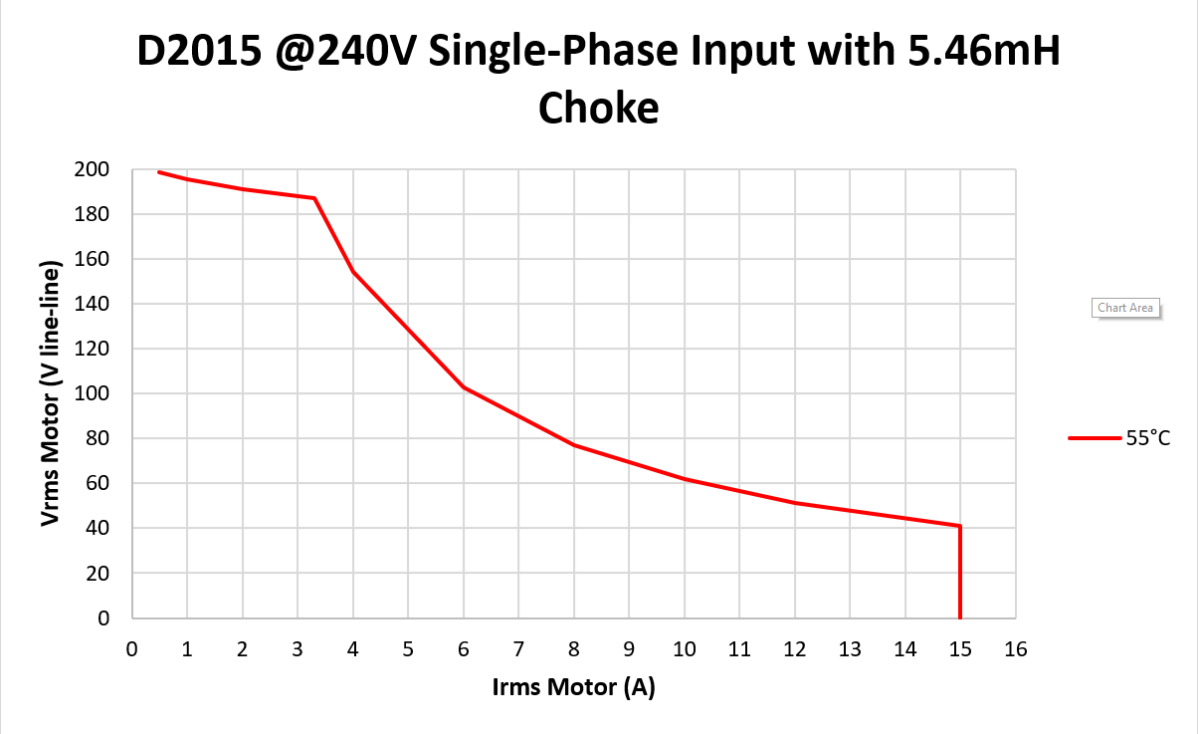


Figure 10-21 D2015 De-rating 1-Phase 240V

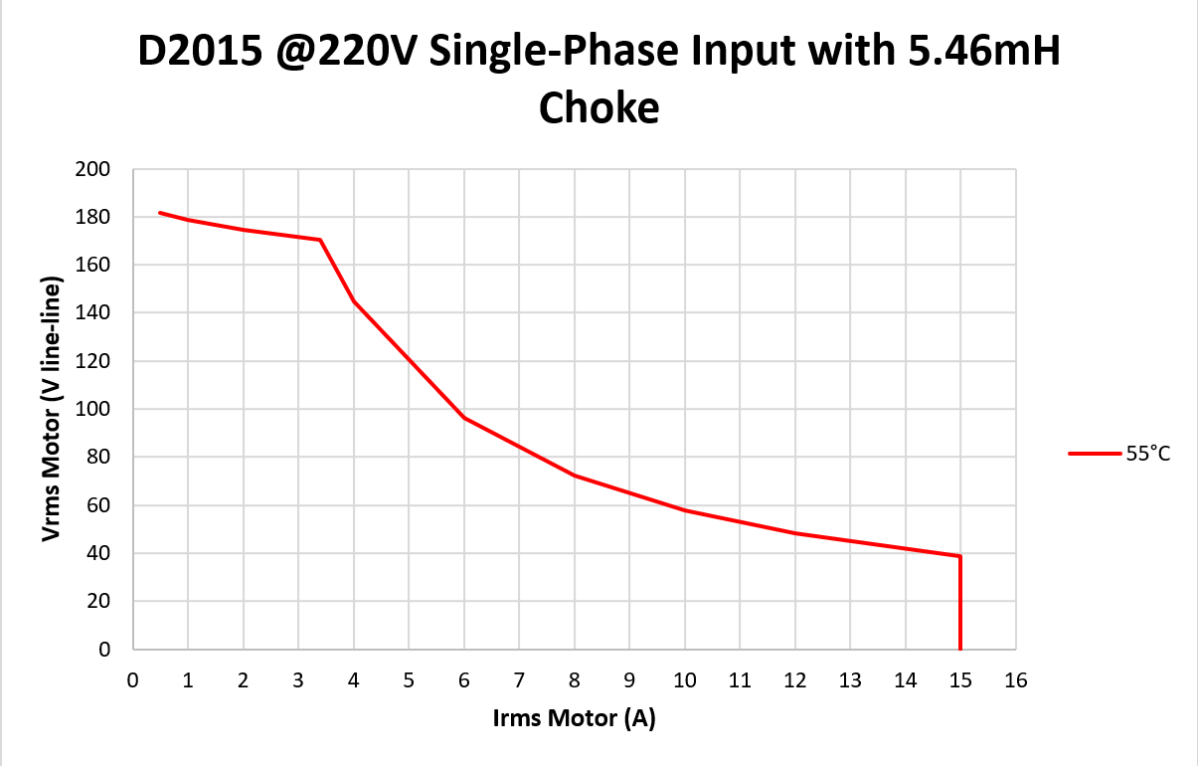


Figure 10-22 D2015 De-rating 1-Phase 220V

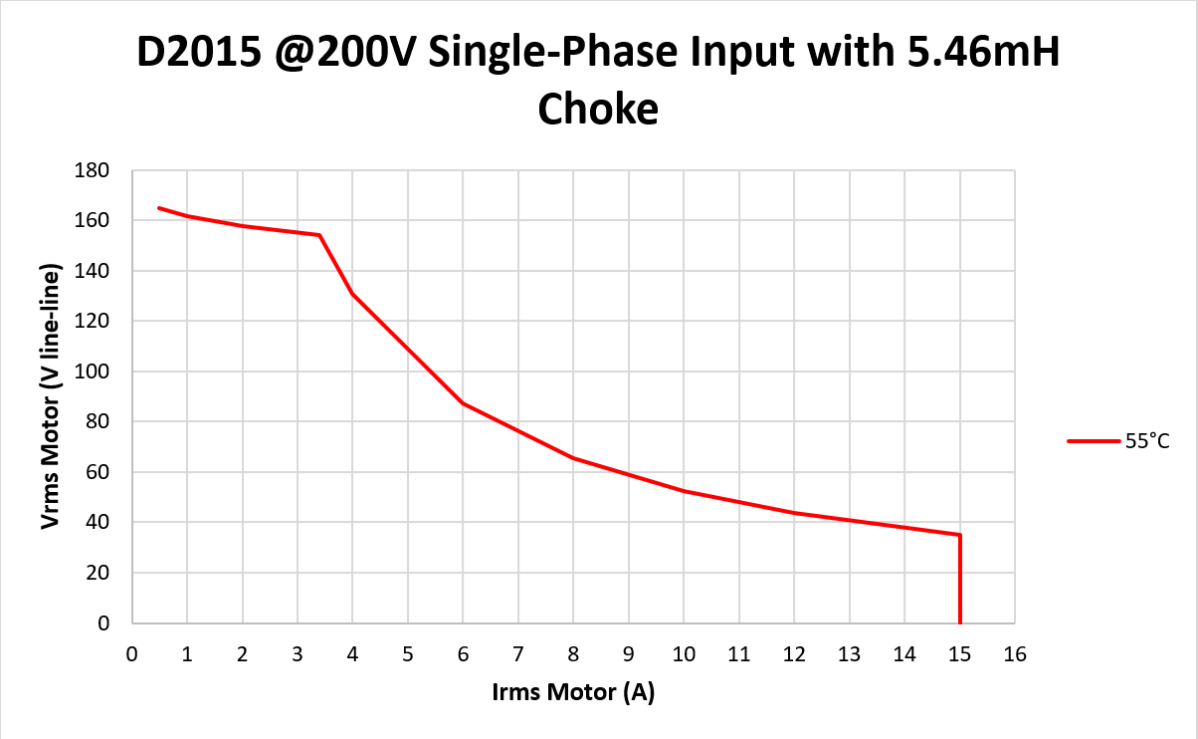


Figure 10-23 D2015 De-rating 1-Phase 200V

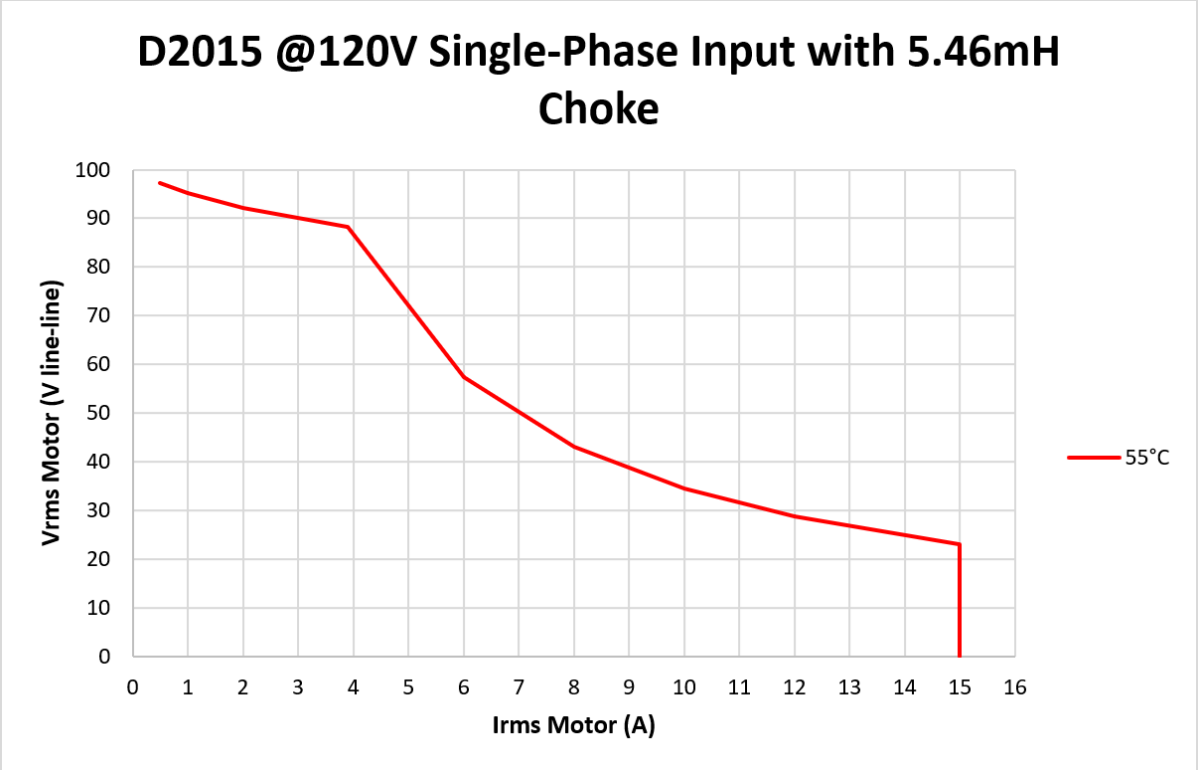


Figure 10-24 D2015 De-rating 1-Phase 120V

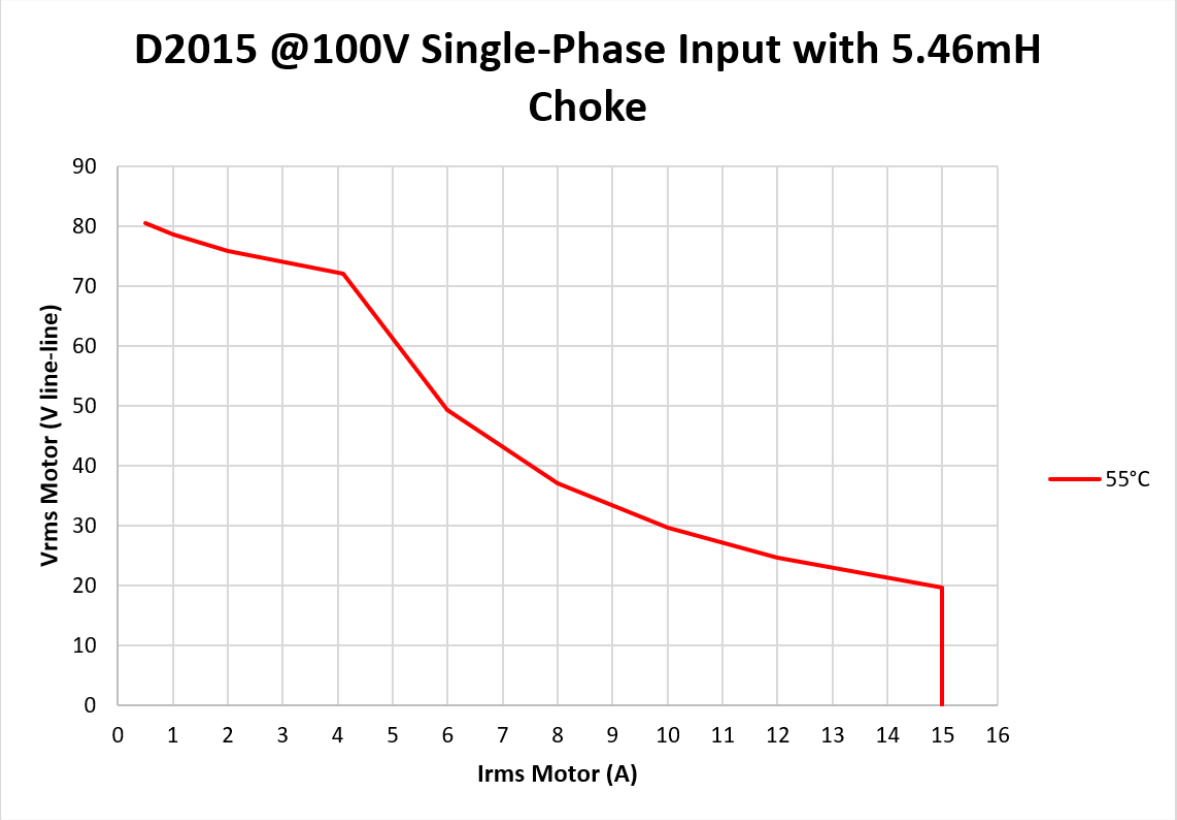


Figure 10-25 D2015 De-rating 1-Phase 100V

10.9.3.2 3-Phase

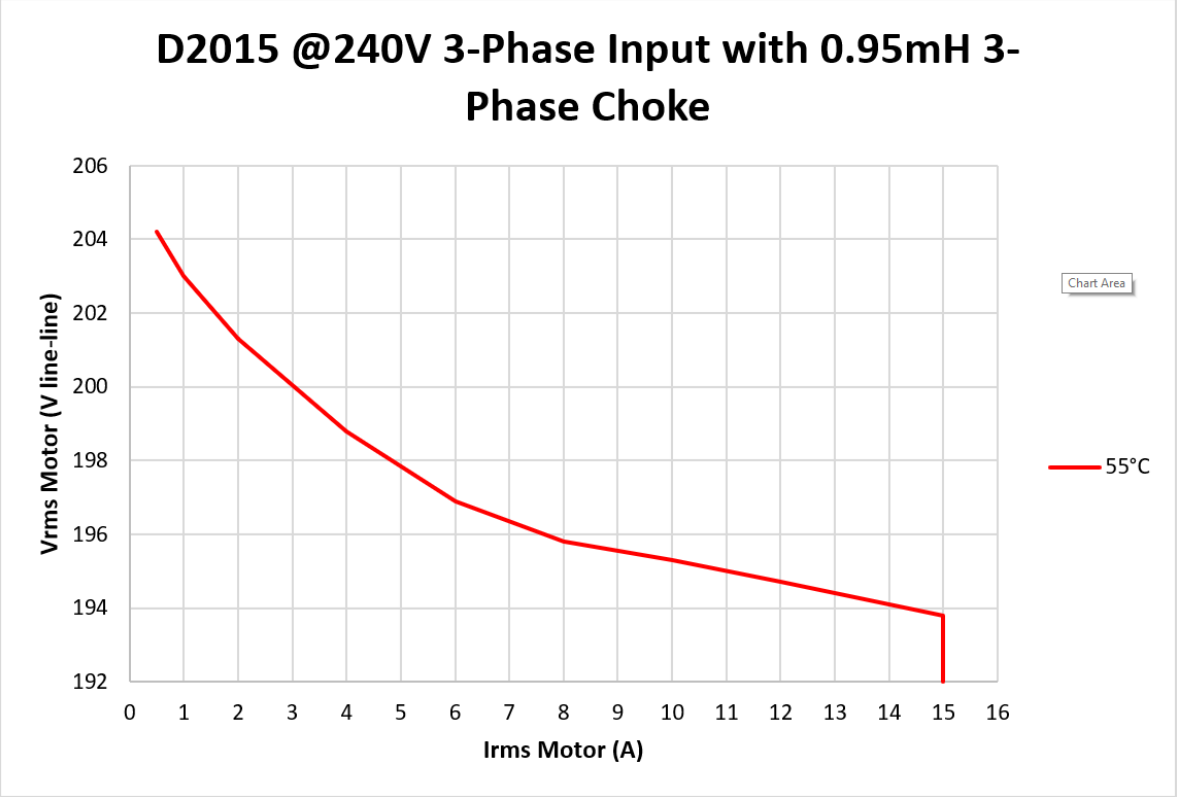


Figure 10-26 D2015 De-rating 3-Phase 240V

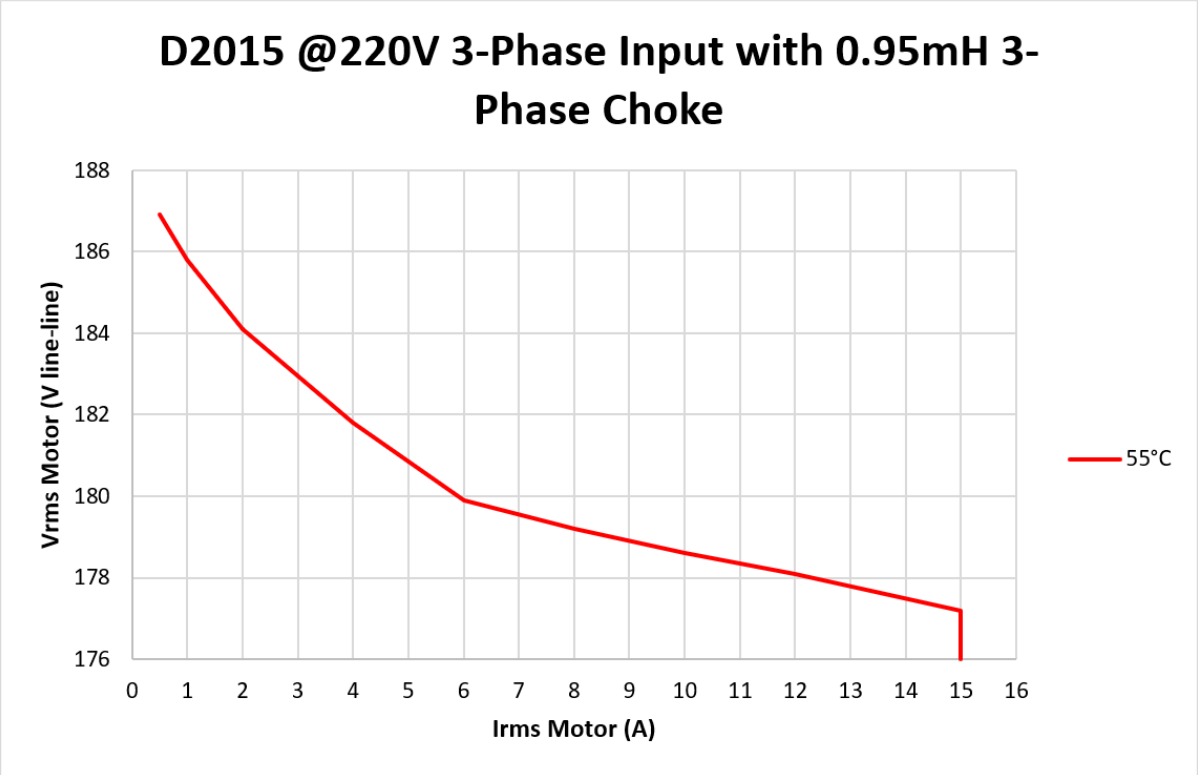


Figure 10-27 D2015 De-rating 3-Phase 220V

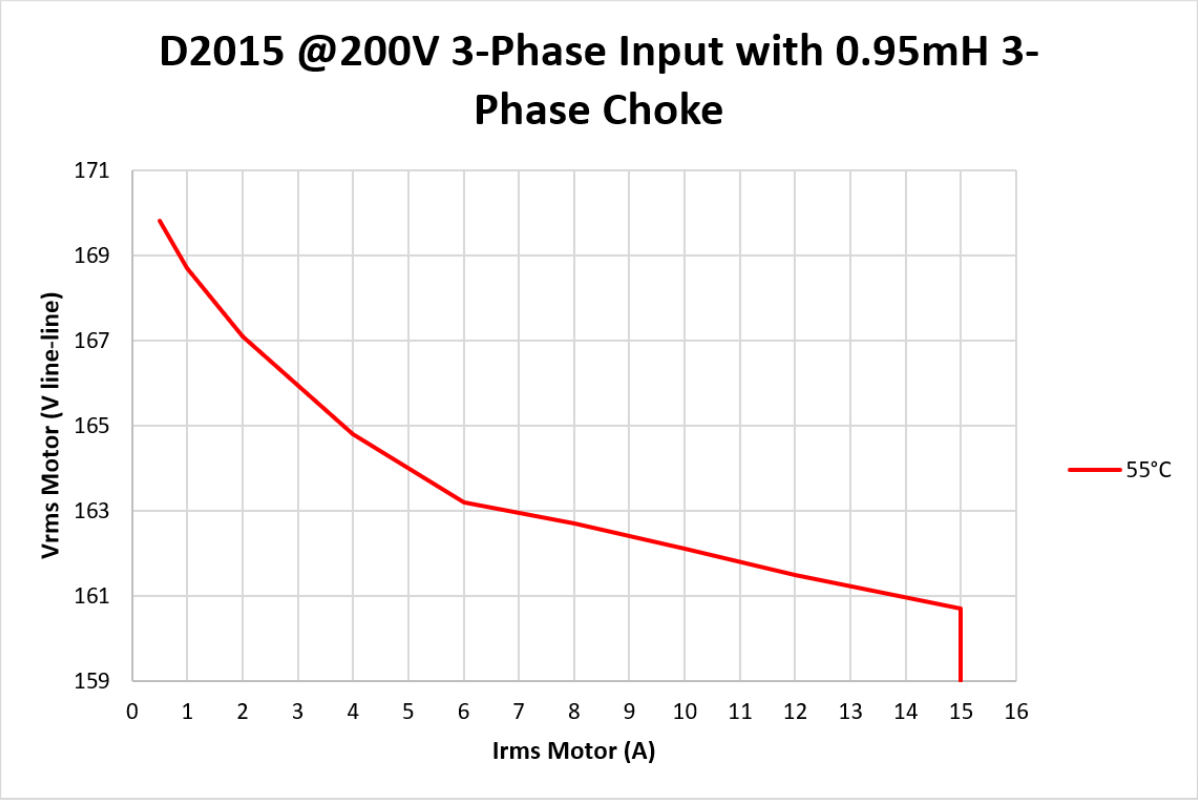


Figure 10-28 D2015 De-rating 3-Phase 200V

10.10 Regeneration Resistor

The AMD2000 Series 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 D2015 and 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 and D2015. If 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 (see section *12.3* for contact details).

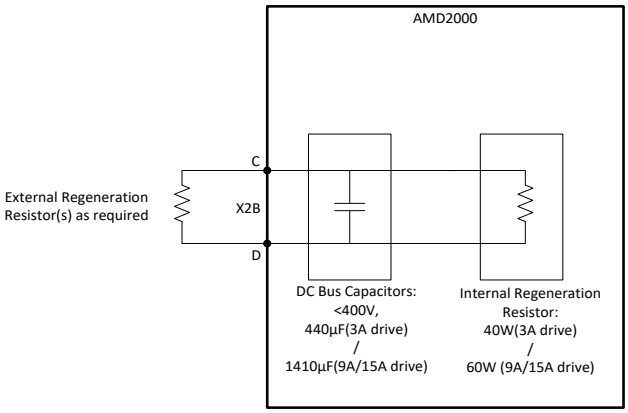


Figure 10-29 Regeneration Resistors and Internal Bus Capacitance

To preserve the integrity and safety of the drive, the MINIMUM external regeneration resistor value shown in *Table 10-1* will apply:

Drive Model	*Rated Current*	*Regen Resistor (min)*
D2103	3 A	51 ohms
D2109	9 A	40 ohms
D2015	15 A	40 ohms

Table 10-1 Minimum External Regeneration Resistor

10.10.1 Calculating the Regeneration Resistor, 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

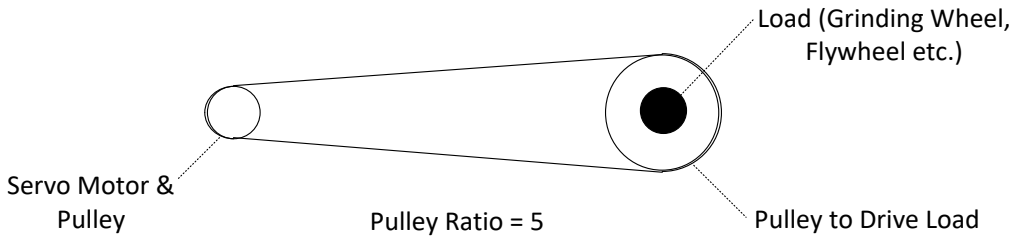
Once the kinetic energy in the system is found, the voltage rise due to the energy on the bus capacitance can be found:

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

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 D2015 and D2109 Drive)

The rise in voltage in this example is then

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

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

$$P = Ef = E * 2$$

10.11 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 part number panels are SABIC Resin 221R with a print finish on the main panel.
Packaging	Cardboard, Expanded Polyethylene (EPE).
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.

Table 10-2 Materials

10.12 Standards Conformity

This chapter details the conformance of the AMD2000 drives to various standards and regulations.

European Community (EC) Directives	EN 61800	Refer to *10.12.1*
EtherCAT Conformance	ETG 1000, ETG 2000 & others	Refer to *10.12.2*
FCC Regulations	Title 47 CFR Part 15 Subpart B	Refer to *10.12.3*

10.12.1 European Community (EC) Directives

The AMD2000 servodrive complies with the following European Community (EC) directives:

EC Machinery Directive	EN 61800-5-2	Refer to *10.12.1.1*
Low Voltage Directive	EN 61800-5-1	Refer to *10.12.1.2*
EMC Directive	EN 61800-3	Refer to *10.12.1.3*
RoHS Directive	2011/65/EU (“RoHS 2”)	

10.12.1.1 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 manual.

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

10.12.1.2 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, D2109 and D2015 are considered 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 manual.

10.12.1.3 EMC Specifications (EN 61800-3 and associated)

The object of standard EN61800-3) 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 AMD2000 drives are intended for use as **Category 3 PDS**, and have been tested and certified to comply for use within what EN61800-3 defines as the second environment. The AMD2000 drives comply with EN61800-3 with the following provisions:

1. The motor and control cables are selected according to the specifications given in the user manual.
2. The drives are installed and maintained according to the instructions given in the user manual.
3. The maximum cable length is 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.

10.12.1.4 EC Directive 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.

Table 10-3 Conformity Definitions

10.12.1.5 EC Declaration of Conformity

The EC Declaration of Conformity for drives D2103 and D2109 with STO functionality appears in *Figure 10-30* and *Figure 10-31*.

The EC Declaration of Conformity for the D2015 non-STO, 15A drive appears in *Figure 10-32* and *Figure 10-33*.

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 Europe Headquarters Im Technologiepark 15 69469 Weinheim Germany

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/A2:2015
EN ISO 13849-1	Safety of machinery – Safety related parts of control systems –General Principles for design	2015

An EC Type Examination Cert (**No. 141006GRa – Issue 2, dated 05/10/19, expires 5/10/2024** 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.

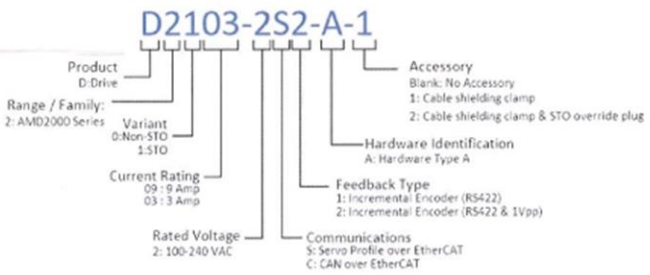
ANCA Motion
EC Declaration of Conformity_AMD2000 STO Servo Drive D2103 D2109

Figure 10-30 D2103 & D2109 EC Declaration of Conformity – page 1 of 2

Appendix

The CE marking applies to the following Catalogue Codes and Accessory Part Numbers.

Catalogue Codes:



Accessories:

Part Number	Description
ICN-1026-1190	I/O Interface Cable
ICN-3077-1952	Interface Module
646-0-05-0723	Breakout Box
619-0-00-0965	Breakout Box Kit
619-0-00-1187	I/O connector
646-0-00-8958	STO Override Plug
619-0-00-1028	D2103 Armature cable shield kit
619-0-02-0957	D2109 Armature cable shield kit
619-0-00-2290	Soft Start Module

Attachment of the CE marking: 2014

Michael Stephens
Engineering Manager
ANCA Motion P/L

8 September 2023

ANCA Motion
EC Declaration of Conformity_AMD2000 STO Servo Drive D2103 D2109

Figure 10-31 D2103 & D2109 EC Declaration of Conformity – page 2 of 2

EC Declaration of Conformity

Product: AMD2000 Servo Drive D2015

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 Europe Headquarters Im Technologiepark 15 69469 Weinheim Germany

In accordance with the following directives:

EU Machinery Directive 2023/1230/EU
EU Electromagnetic Compatibility 2014/30/EU
EU RoHS Directive 2015/863
EU Low voltage Directive 2014/35/EU

Herewith declare that the D2015 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 D2015 servo drive has been evaluated as complying with the following harmonized standards and all appropriate associated standards:

Standard	Title	Ed./Date
EN 61800-5-1	Adjustable Speed Electrical Power Drive Systems, Part 5-1: Safety Requirements – Electrical, thermal and energy	2007+A1:2017+A11:2021
IEC 61800-5-1	International standards for Adjustable Speed Electrical Power Drive Systems, Part 5-1: Safety Requirements – Electrical, thermal and energy	2007; AMD1 2016
EN 61800-3	Adjustable Speed Electrical Power Drive Systems, Part 3: EMC requirements and specific test methods	2018
IEC 61800-3	International standard for Adjustable Speed Electrical Power Drive Systems, Part 3: EMC requirements and specific test methods	2017

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

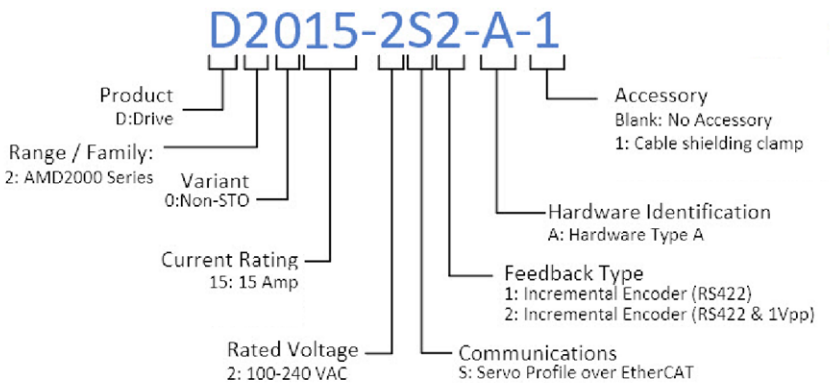
ANCA Motion EC Declaration of Conformity_AMD2000 Non STO Servo Drive D2015

Figure 10-32 D2015 EC Declaration of Conformity – page 1 of 2

Appendix

The CE marking applies to the following Catalogue Codes and Accessory Part Numbers.

Catalogue Codes:



Accessories:

Part Number	Description
ICN-1026-1190	I/O Interface Cable
ICN-3077-1952	Interface Module
646-0-05-0723	Breakout Box
619-0-00-0965	Breakout Box Kit
619-0-00-1187	I/O connector
619-0-00-2265	D2015 Armature cable shield kit
619-0-00-2290	Soft Start Module

Attachment of the CE marking: 26th October 2023

Matt Mannix
General Manager
ANCA Motion P/L
26th October 2023

ANCA Motion EC Declaration of Conformity_AMD2000 Non STO Servo Drive D2015

Figure 10-33 D2015 EC Declaration of Conformity – page 2 of 2

10.12.2 EtherCAT® Conformance Marking

An EtherCAT[1] device conformance mark appears on the product label to indicate the drive conforms to the following EtherCAT Technology Group (ETG) standards:

ETG 1000	EtherCAT Specification
ETG 2000	EtherCAT Slave Information
ETG 2100	EtherCAT Network Information Specification
ETG 7000	EtherCAT Conformance Test Specification
ETG 9001	EtherCAT Marking Rules
ETG 1300	EtherCAT Indicator and Labelling Specification

Self-determination of compliance was achieved with the ETG Conformance Test Tool, rather than third-party certification. The AMD2000 drive conforms to communication standard IEC 61158.

10.12.3 FCC Notices

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by ANCA Motion could void the user's authority to operate the equipment.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

10.12.4 FCC Marking

A FCC mark is attached to the Product Label in order to verify that the unit meets the relevant Electromagnetic Compliance (EMC) standards of the Federal Communications Commission.

[1] 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 catalogue numbers and ordering information for a range of accessories available for the AMD2000 Series servo drive. Web links to the ANCA Motion product pages are provided for the various accessories, including links to a variety of sales brochures, product catalogues and technical manuals.

Please contact ANCA Motion for further information regarding AMD2000 Series servo drive accessories; see section *12.3* for contact details.

11.2 Servo Motors

Figure 11-1 shows a wide range of rotary and linear servo motors that can be used with the AMD2000 Servo Drive product range.

Figure 11-1 AMD2000 Servo Drive with a variety of rotary and linear servo motors

The ANCA Motion Gamma and Alpha rotary servo motors have a large range of frame size, current, speed and torque ratings; with a variety of analogue and digital encoder options and a resistive temperature sensor compatible with the AMD2000 servo drives.

The ANCA Motion M-Series and S-Series linear servo motors have a wide range of shaft lengths, force and speed ratings, and kits for various mounting and cooling options. The LinX linear motor incorporates both analogue and digital encoder signals, and a resistive temperature sensor compatible with the AMD2000 drives.

11.2.1 Gamma Rotary Servo Motor

The Gamma Motor Catalogue contains customer ordering information, detailed descriptions of the available options, dimensional drawings and technical specifications.

The Gamma Motor Catalogue can be downloaded from the ANCA Motion web site:
https://motion.anca.com/Anca.Motion/media/Catalogues/Gamma-Motor-Catalogue-EN-V1.pdf

Refer to the Gamma Servo Motor web page for more information:
https://motion.anca.com/Products/Motors/Motors/Gamma-Motors

11.2.2 Alpha Rotary Servo Motor

The Alpha servo motor dimensional drawings and technical specifications can be found in the sales brochure; which can be downloaded from the ANCA Motion web site:
https://motion.anca.com/Anca.Motion/media/Brochures/20221004-Alpha-Servo-Motor.pdf

Refer to the Alpha Servo Motor web page for more information:
https://motion.anca.com/Products/Motors/Motors/Alpha-Motors

11.2.3 LinX® M-Series Linear Motor

The LinX® M-Series tubular linear motor consists of a TLM forcer with optional mounting and cooling kits, and a TLS shaft ordered separately.

Refer to the LinX® M-Series Linear Motor User Manual for customer ordering information, detailed descriptions of the available options, technical drawings and specifications.

The user manual can be downloaded from the LinX® M-Series Linear Motor web page:
https://motion.anca.com/Products/Motors/LinX-Linear-Motors/LinX%C2%AE-M-Series

11.2.4 LinX® S-Series Linear Motor

The LinX® S-Series tubular linear motor consists of a TLM forcer with various coil, connector and housing options, and a TLS shaft ordered separately.

Refer to the LinX® S-Series Linear Motor User Manual for customer ordering information, detailed descriptions of the available options, technical drawings and specifications.

The user manual can be downloaded from the LinX® S-Series Linear Motor web page:
https://motion.anca.com/Products/Motors/LinX-Linear-Motors/LinX%C2%AE-S-Series

11.3 Motor Cables

ANCA Motion supplies a large range of high-quality cable assemblies to connect Alpha, Gamma and LinX® servo motors to the AMD2000 servo drives.

The Motor Cable Catalogue contains customer ordering information, dimension drawings, connector types, pinouts, and technical specifications.

The Motor Cable Catalogue can be downloaded from the ANCA Motion web site:
https://motion.anca.com/Anca.Motion/media/Catalogues/AMDOC-000795_Motor-Cables-Catalogue.pdf

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-3077-1952	AMD2000 I/O Interface Module – I/O as described in Chapter *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 section *7.5.2.2.2* for detailed operation.

11.4.3 I/O Interface Module Kit

Part Number	Description
619-0-00-0965	*AMD2000 I/O Interface Module Kit* 1 x AMD2000 I/O Interface Module 1 x AMD2000 I/O Interface Cable

11.4.4 I/O Connector

Part Number	Description
619-0-00-1187	*AMD2000 I/O Connector* - 50 Way Mini D Ribbon (MDR) Male with M2.5 jack screws 1 x Plug, MDR 50 Way Male, Solder, Shielded 1 x Backshell, MDR 50 Way, Screw Type

Warning: The I/O 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 D2103 and D2109 STO Override Plug

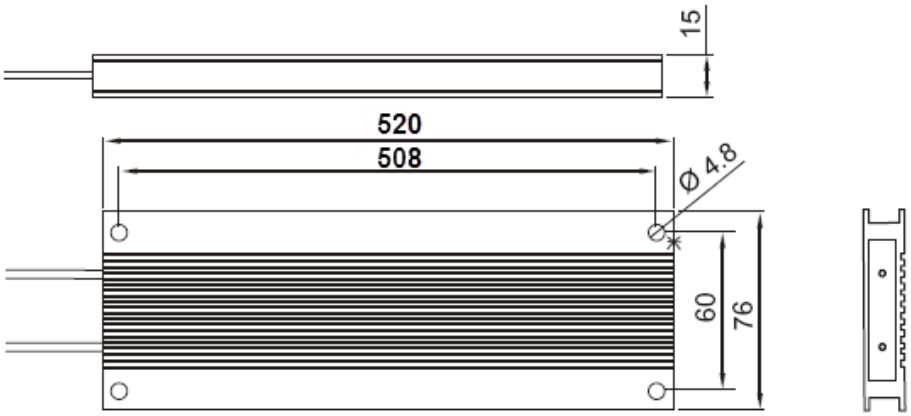
Part Number	Description
646-0-00-8958	D2103 and D2109 STO Override Plug

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 will override the STO function.

11.4.6 Regen Resistors

11.4.6.1 Aluminium-clad Regen Resistor

Part Number	Description
ICN-3009-0317	Aluminium-clad regen resistor, 36 Ω ± 10%, 500 W (with heatsink), 300 W (without heatsink), 17 kW for 1 sec.

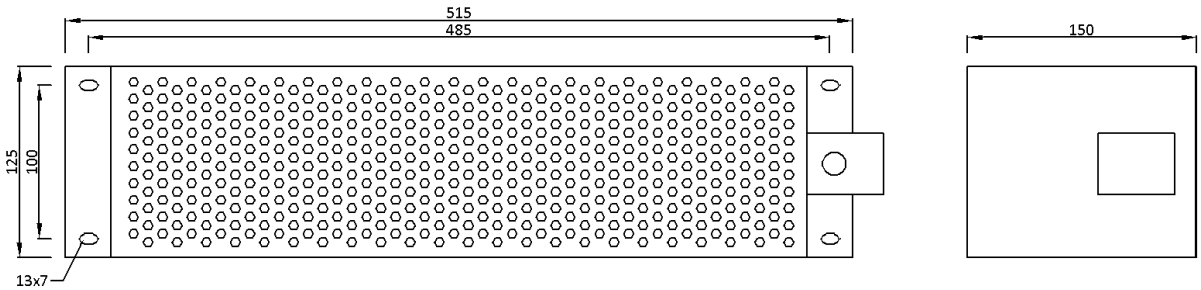


11.4.6.2 Regen Resistor Over-temperature Switch

Part Number	Description
ICN-3079-0341	Regen resistor over-temperature switch, open above 70 °C, TO-220 package

11.4.6.3 Regen Resistor with Enclosure and Over-Temperature Switch

Part Number	Description
ICN-3009-0850	Aluminium clad braking resistor with steel enclosure and over-temperature switch. Resistor: 36 Ω ± 10%, 375 W Temperature switch: 180 °C, 24 kW for 1 sec.



11.4.7 Power Supply Soft Start Module

Part Number	Description
619-0-00-2290	AMD2000 Power Supply Soft Start Module

11.4.8 Motor Thermistor Isolation Module

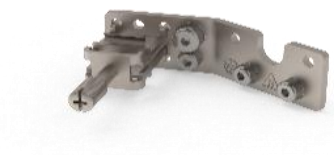
Part Number	Description
619-0-00-1580	AMD2000 Motor Thermistor Isolation Module

11.4.9 EtherCAT Cables

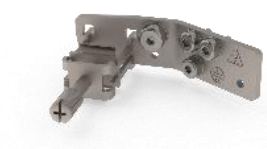
Part Number	Description
KXE-1100-0002	Ethernet Cable, Cat 5e, SF/UTP, 0.2 m
KXE-1100-0005	Ethernet Cable, Cat 5e, SF/UTP, 0.5 m
KXE-1100-0010	Ethernet Cable, Cat 5e, SF/UTP, 1.0 m
KXE-1100-0015	Ethernet Cable, Cat 5e, SF/UTP, 1.5 m
KXE-1100-0020	Ethernet Cable, Cat 5e, SF/UTP, 2.0 m
KXE-1100-0030	Ethernet Cable, Cat 5e, SF/UTP, 3.0 m
KXE-1100-0050	Ethernet Cable, Cat 5e, SF/UTP, 5.0 m
KXE-1100-0075	Ethernet Cable, Cat 5e, SF/UTP, 7.5 m
KXE-1100-0100	Ethernet Cable, Cat 5e, SF/UTP, 10 m
KXE-1100-0150	Ethernet Cable, Cat 5e, SF/UTP, 15 m
KXE-1100-0200	Ethernet Cable, Cat 5e, SF/UTP, 20 m
KXE-1100-0300	Ethernet Cable, Cat 5e, SF/UTP, 30 m

11.4.10 Motor Armature Cable Shield Termination Kit

Part Number	Description
619-0-00-1028	D2103 Drive Armature Cable Shield Termination Kit
619-0-02-0957	D2109 Drive Armature Cable Shield Termination Kit
619-0-00-2265	D2015 Drive Armature Cable Shield Termination Kit



D2103 Cable Bracket Kit



D2109 Cable Bracket Kit

D2015 Cable Bracket Kit

11.5 Drive Kit Order Codes

The AMD2000 Series drives may be purchased stand-alone or in kit form (see catalogue code in *Figure 3-3*).
For example:

- D2xxx-2S2-A-1 Servodrive with Armature Cable Shield Termination Kit
- D2xxx-2S2-A-2 Servodrive with Cable Shield Termination Kit and STO Override Kit

The kit contents are shown in the following tables.

11.5.1 D2103 Drive 3A with Cable Bracket Kit

Part Number	*Description*
D2103-2S2-A-1	*D2103 Drive 3A with Cable Bracket Kit* 1 x AMD2000 3A Servo Drive with STO 1 x Armature Shield Termination Bracket 1 x EMC Shield Saddle Clamp 3 x Screw SHCS M4x10 Locktooth Washer 1 x Screw M6x10 Locktooth Washer

11.5.2 D2103 Drive 3A with Cable Bracket Kit & STO Override Plug

Part Number	*Description*
D2103-2S2-A-2	*D2103 Drive 3A with Cable Bracket Kit and STO Override Plug* 1 x AMD2000 3A Servo Drive with STO 1 x Armature Shield Termination Bracket 1 x EMC Shield Saddle Clamp 3 x Screw SHCS M4x10 Locktooth Washer 1 x Screw M6x10 Locktooth Washer 1 x STO Override Plug

11.5.3 D2109 Drive 9A with Cable Bracket Kit

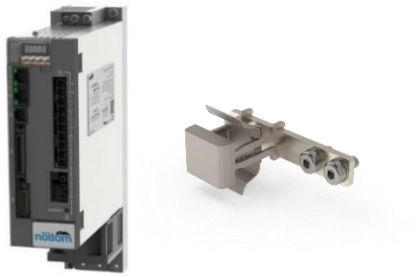
Part Number	Description
D2109-2S2-A-1	*D2109 Drive 9A with Cable Bracket Kit* 1 x AMD2000 9A Servo Drive with STO 1 x Armature Shield Termination Bracket 1 x EMC Shield Saddle Clamp 3 x Screw SHCS M4x10 Locktooth Washer 1 x Screw M6x10 Locktooth Washer

11.5.4 D2109 Drive 9A with Cable Bracket Kit & STO Override Plug

Part Number	Description
D2109-2S2-A-2	*D2109 Drive 9A with Cable Bracket Kit and STO Override Plug* 1 x AMD2000 9A Servo Drive with STO 1 x Armature Shield Termination Bracket 1 x EMC Shield Saddle Clamp 3 x Screw SHCS M4x10 Locktooth Washer 1 x Screw M6x10 Locktooth Washer 1 x STO Override Plug

11.5.5 D2015 Drive 15A with Cable Bracket Kit

Part Number	Description
D2015-2S2-A-1	*D2015 Drive 15A with Cable Bracket Kit* 1 x AMD2000 15A Servo Drive 1 x Armature Shield Termination Bracket 1 x EMC Shield Saddle Clamp 3 x Screw SHCS M4x10 Locktooth Washer 1 x Screw Pan Head M3x6 with Spring



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 this user manual.

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 Chapter *4 Mechanical Installation* for site requirements, tools, and installation information.

The AMD2000 Series drive has no internal adjustments; please contact your nearest ANCA Motion office or agent for service and repair enquiries. Refer to section *12.3* for contact information.

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
Victoria 3153
AUSTRALIA
Telephone: +613 9751 8900
Fax: +613 9751 8901
Web: www.ancamotion.com/Contact-Us
Email: sales.au@ancamotion.com

ANCA Motion Taiwan
4F, No. 63, Jingke Central Road
Nantun District
Taichung City 40852
TAIWAN
Telephone: +886 4 2359 0082
Fax: +886 4 2359 0067
Web: www.ancamotion.com/Contact-Us
Email: sales.tw@ancamotion.com

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Xiqing Economic-technological Development Area
Tianjin, P.R.CHINA
Telephone: +86 22 5965 3760
Fax: +86 22 5965 3761
Web: www.ancamotion.com/Contact-Us
Email: sales.cn@ancamotion.com

12.4 Feedback

This user manual is based on information available at the time of publication. Reasonable precautions have been taken in the preparation of this user manual, 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