Motion Control Solutions

AMD5x Passive Infeed Unit and AMD5x Servo Drive - User Guide

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AMD5x Passive Infeed Unit and AMD5x Servo Drive - User Guide

Some Important Links

Related Manuals and Brochures	*Related Documentation*
Sales and Support Contact Information	*Product, Sales and Service Enquiries*
User manual	*Manuals*
MotionBench	*Software*

Documents Reference: D-000129 Revision: 09

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Chapter Summaries

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Contents

1 Safety

Warning: To prevent possible accidents or injury, ensure you read and understand this manual before commencing installation or commissioning work on the AMD5x PIU and Servo Drives.

DANGER HIGH VOLTAGE - The working DC Bus is live at **all** times when mains power is on, even if the bus is discharged. 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 DC Bus voltage with a tested working voltage measuring instrument prior to removing any covers

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

This manual and the warnings attached to the AMD5x 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 manual you can help to ensure your own safety and the safety of those around you.

The AMD5x 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.

The AMD5x system is an Open Type product; the associated module enclosures are rated to IP20 and are classified as NEMA/UL Open Type. The AMD5x modules must be mounted within an enclosure which provides access protection, with access only possible with a use of a tool or after de-energization of the live parts.

1.1 General Safety

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

- Equipment operators must read the User Manual carefully and make sure of the correct procedure before operating the AMD5x.
- Memorize the locations of the power and drive isolator switches so that you can activate them immediately at any time if required.
- If two or more persons are working together, establish signals so that they can communicate to confirm safety before proceeding to another step.
- Always make sure there are no obstacles or people near the devices during installation and or operation. Be aware of your environment and what is around you.
- Take precautions to ensure that your clothing, hair or personal effects (such as jewellery) cannot become entangled in the equipment.
- Do not remove the covers to access the inside of the AMD5x unless instructed by the procedures described in this manual.
- Do not turn on any of the equipment without all safety features in place and known to be functioning correctly.
- 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 AMD5x, which may cause malfunction or failure.
- Before removing equipment covers, be sure to turn OFF the power supply at the isolator (refer to *5.3.1 Power Isolation*.)
- Do not operate AMD5x equipment with the covers removed.
- Keep the vicinity of the AMD5x clean and tidy.

- Never attempt cleaning or inspection during machine operation.
- Only suitably qualified personnel should install, operate, repair and/or replace this equipment.
- Be aware of the closest First Aid station.
- Ensure all external wiring is clearly labelled. This will assist you and your colleagues in identifying possible electrical safety hazards.
- Clean or inspect the equipment only after isolating all power sources.
- Use cables with the minimum cross-sectional area as recommended or greater.
- Install cables according to local legislation and regulations as applicable.
- The AMD5x modules must be mounted within an enclosure which provides access protection, with access only possible with a use of a tool or after de-energization of the live parts.
- Do not touch heatsinks during drive system function as they may be hot. Care must be taken to avoid burns.

Warning: Insulation resistance testers (megohmmeter) are not to be used on AMD5x PIU and Servo Drives, as a false resistance reading and/or damage to the tested equipment may result. Refer *5.11 Checking the Insulation of the Assembly*

2 Introduction

2.1 What This Chapter Contains

This chapter introduces the reader to the AMD5x Product range and related ANCA Motion products.

2.2 Purpose

This manual provides the required information for planning to install, installation and servicing of the AMD5x PIU and Servo Drive. It has been written specifically to meet the needs of qualified engineers, tradespersons, technicians and operators. This manual does not cover configuration of the drive. Depending on the model of drive purchased, please refer to the applicable Servo over EtherCAT Configuration Guide or CANopen over EtherCAT Configuration Guide, for information on parameter configuration and tuning for your application.

Every effort has been made to simplify the procedures and processes applicable to the AMD5x in this User Guide. However, given the sometimes complex nature of the information, some prior knowledge of associated units, their configuration and or programming has to be assumed.

2.3 About The AMD5x Series Passive Infeed Units

The AMD5x Passive Infeed Unit (PIU) is the power input component of the AMD5x system. The PIU converts AC mains into a DC supply which is distributed to the servo drives on common DC Bus. It is called “passive” because there is no regulation of the conversion (rectification) process, and no ability to regenerate excess energy back into the mains supply. The PIU also distributes the customer supplied 24 Vdc control voltage to all drives.

Please refer to *3.5.1 PIU* for more system details.

2.4 About The AMD5x Series Servo Drives

The AMD5x 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.

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. The Drive control receives motion control commands via a higher level controller, which is based on an Ethernet-based field-bus interface. The AMD5x Drive also supports position, velocity and torque control modes.

AMD5x Drives equipped with an integral IO Interface provide a core Servo Drive function along with a generic Input/Output (IO) Interface to support customer IO requirements. These Drives are used in Servo Motor Drive Systems requiring additional IO control and detection for external transducers and other control/measurement equipment.

AMD5x Drives support both absolute and incremental encoders. Each drive has two analogue 1Vpp encoder inputs, and can also support incremental ABZ and absolute encoders such as Hiperface DSL and BiSS.

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

2.5 About The AMD5x Capacitor Module

The AMD5x Capacitor Module is an optional product which adds additional DC Bus capacitance to the drive system so that excess energy in regenerative applications can be reused by all drives. Adding DC Bus capacitance also reduces braking resistor losses, minimises braking resistor size, and reduces electrical supply costs.

2.6 PIU Model Applicability

AMD5x Series PIU Catalogue Numbers are shown in *Figure 2-1*. AMD5x PIU is marked with an identification label. The Catalogue number is explained as follows:

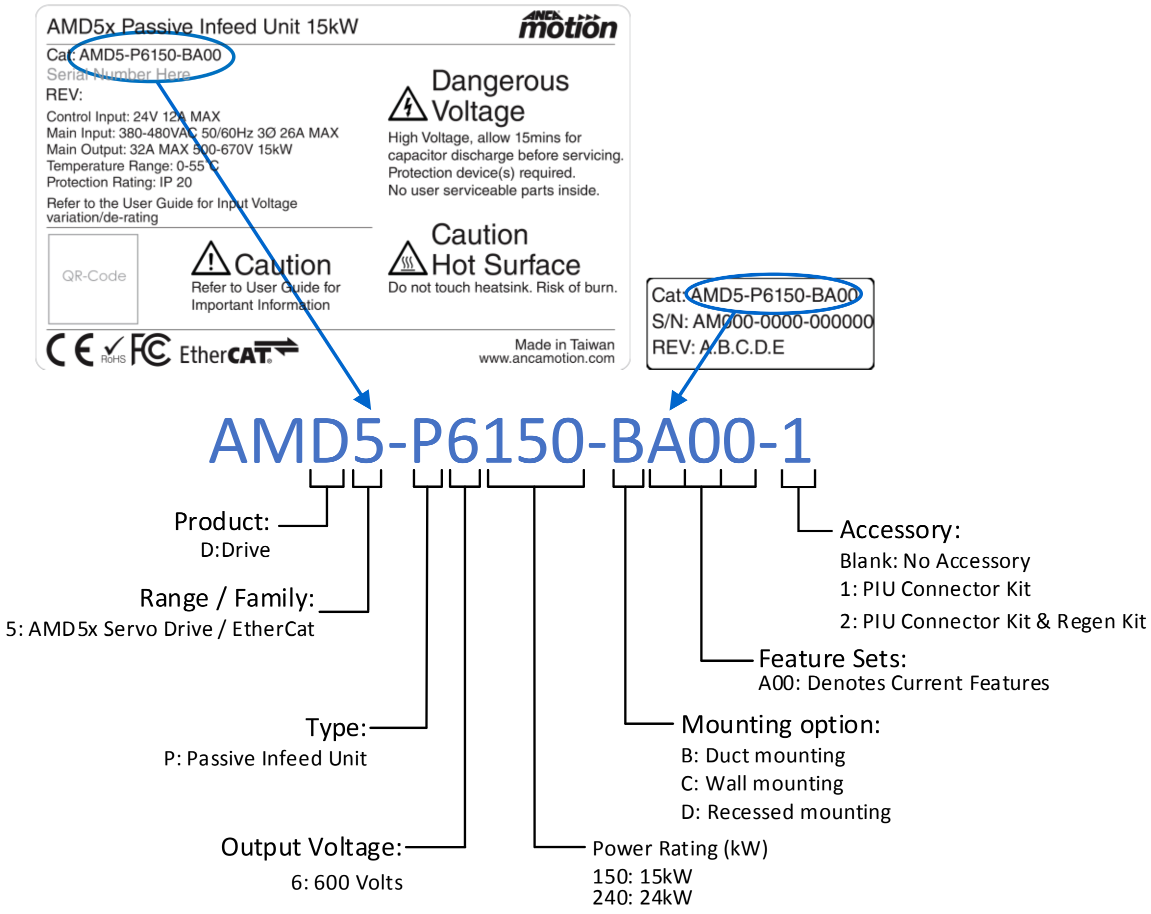


Figure 2-1: AMD5x Series PIU Catalogue number interpretation

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. The warranty may be void if the labels are damaged.

Note: At least one Capacitor Module is required when employing the 24kW PIU (AMD5-P6240-_____).

2.7 Drive Model Applicability

AMD5x Series Drives Catalogue Numbers are shown in *Figure 2-2*. AMD5x drives are marked with an identification label. The Catalogue number is explained as follows:

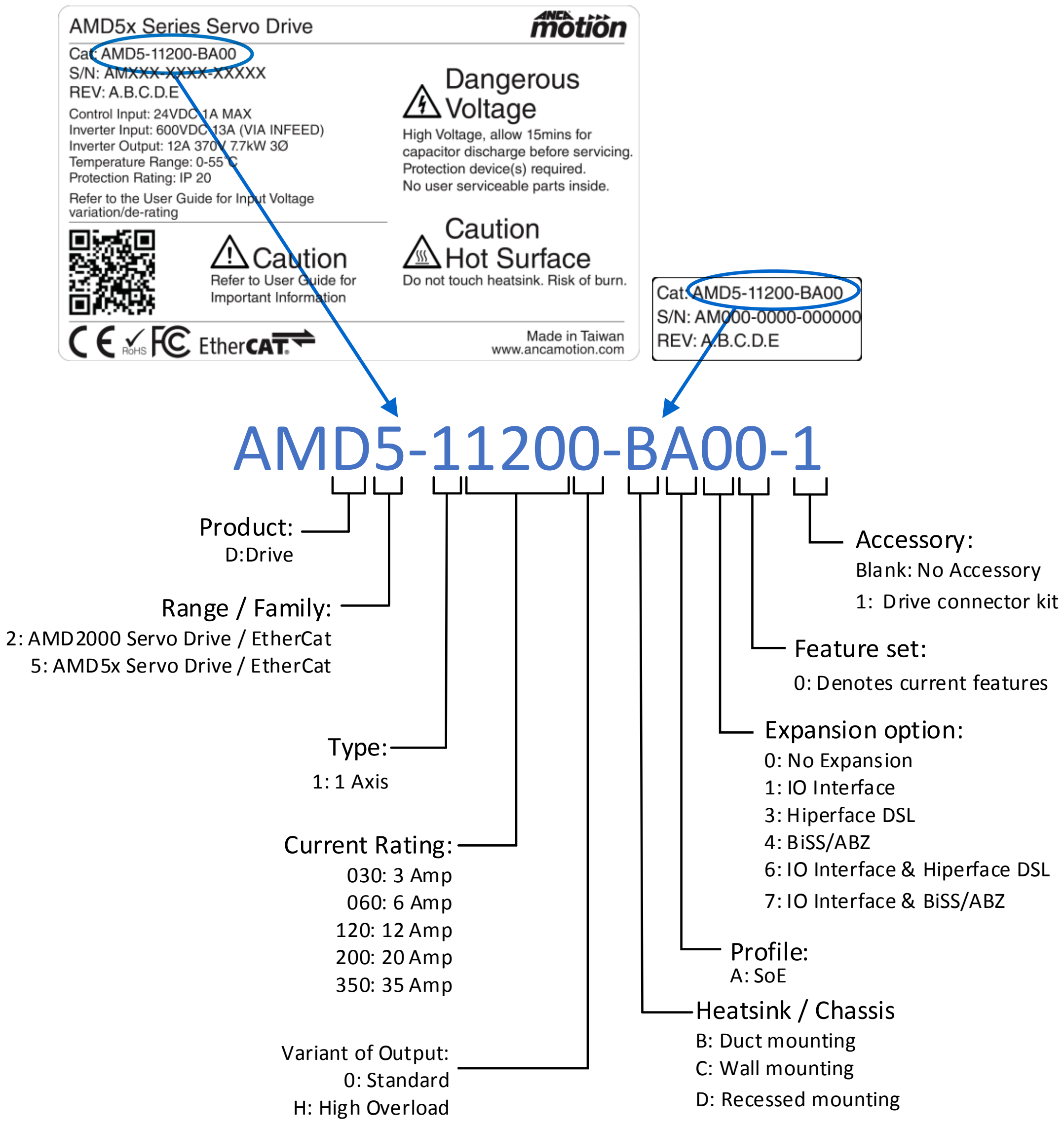


Figure 2-2: AMD5x Series Servo Drive Catalogue number interpretation

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 : The 35A Drives do not have FCC compliance, hence the FCC logo will not be on the 35A labels.

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

2.8 Capacitor Module Model Applicability

AMD5x Series Capacitor Module Catalogue Numbers are shown in *Figure 2-3*. AMD5x Capacitor Module is marked with an identification label. The Catalogue number is explained as follows:

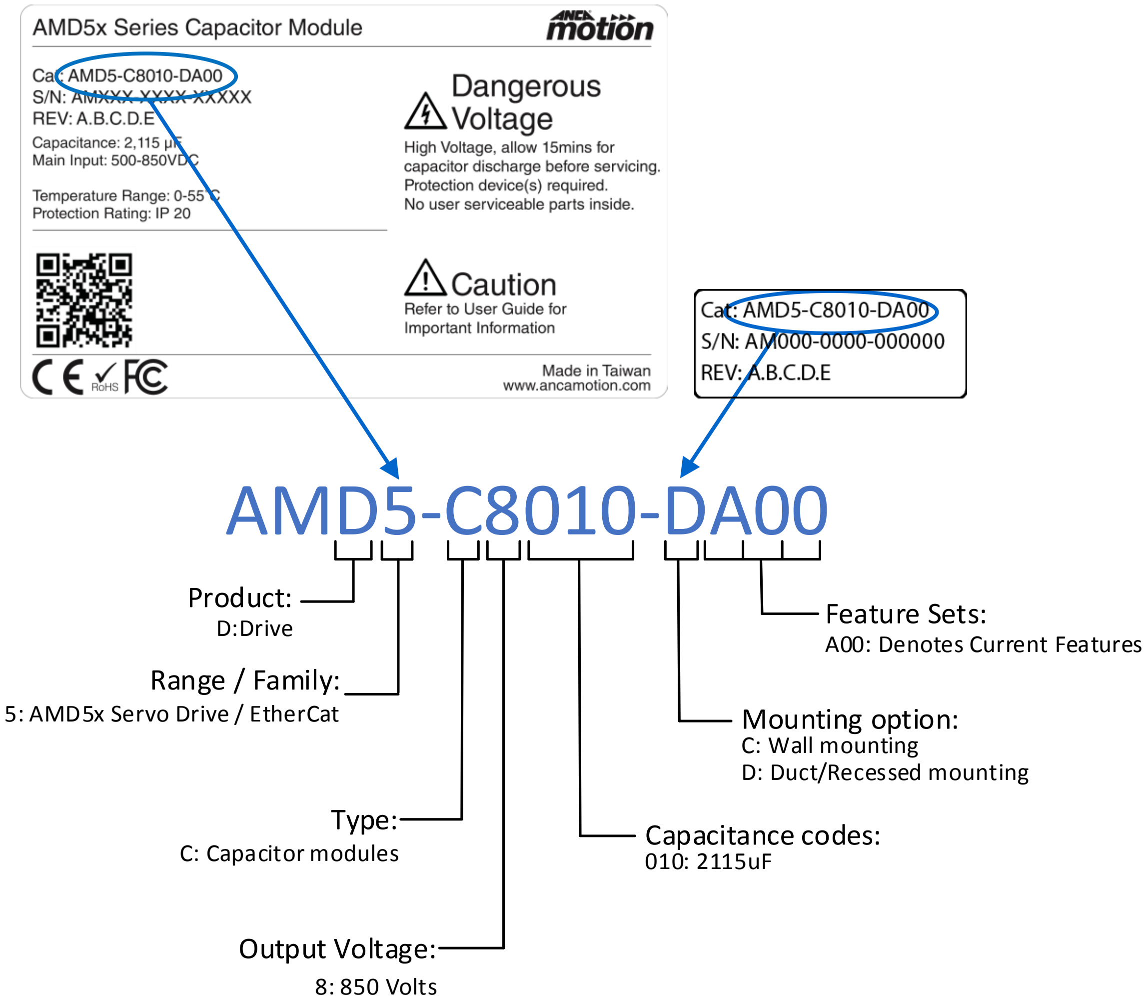


Figure 2-3: AMD5x Series Capacitor Module Catalogue number interpretation

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. The warranty may be void if the labels are damaged.

2.9 Related Documents

AMDOC-0000192 AMD5x Series Servo Drive – SoE Configuration Guide

D-000101 ANCA Motion MotionBench – User Guide

Digital Servo Drive SoE Parameter Reference – Included with firmware bundle

Digital Servo Drive Error Code Reference – Included with firmware bundle

To obtain these documents, contact your local ANCA Motion sales office. See *12.3 Product, Sales and Service* Enquiries.

2.10 Trademarks

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

HIPERFACE DSL® is a registered trademark of SICK STEGMANN GmbH

BiSS Interface is an Open Source Protocol

2.11 Terms and Abbreviations

Table 1: Terms and Abbreviations

Acronym	Description
Φ	Mains supply phase
Ø	Diameter
Ω	Ohms
AIN / AI	Analogue Input
AOUT / AO	Analogue Output
A / mA	Ampere / milliamp
AC / DC	Alternating Current / Direct Current
BiSS	Bidirectional Synchronous Serial
CNC	Computer Numerical Control
DI	Digital Input
DO	Digital Output
DO-GP / DO-HS	Digital Output: General Purpose / High Speed
DCM	Drive-Controlled Moves
DSD	Digital Servo Drive
DSP	Digital Signal Processor
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
ESD	Emergency Stop Device
GND	Ground
Hiperface DSL	Hiperface Digital Servo Link
Hz	Hertz
IEC	International Electrotechnical Commission
IGBT	Insulated Gate Bipolar Transistor
IO	Input Output
I/O	Bidirectional Input / Output
LVD	Low Voltage Directive, CE 2014/35/EU
ms	Millisecond
O	Output
PCBA	Printed Circuit Board Assembly
PE	Protective Earth
PIU	Passive Infeed Unit
PMAC	Permanent Magnet Alternating Current
PMSM	Permanent Magnet Servo Motor
QEP	Quadrature Encoder Pulse
RMS	Root Mean Square
SE	Single Ended
SELV	Safe Extra Low Voltage
SoE	Servo over EtherCAT
STO	Safe Torque Off
V / mV	Volt / millivolt
W.R.T.	With Respect To

3 Product Overview

3.1 What This Chapter Contains

This chapter will provide the following information:

- Features
- Operating Principle
- Explanation of Labelling and Markings
- Electrical Connections

3.2 Features

The AMD5x is a multi-axis servo drive system controlled by an external CNC via EtherCAT interface.

Standard features include:

- Variable mounting options (Duct, Recessed, Wall Mount).
- Conformal Coating on Recessed and Wall Mount versions.
- Drive models with continuous current ratings of 3A, 6A, 12A, 20A, or 35A.
- Connection to 380-480VAC 3 phase.
- Easy setup using ANCA Motion MotionBench Configuration Tool.
- EtherCAT connectivity.
- Position, velocity and torque/current control.
- Support for incremental analogue encoders.
- High bandwidth encoder channels and current sensing.
- Encoder monitoring and protection.
- Probe inputs for position latching.
- Motor brake control.
- Capacitor modules for high regeneration applications
- Isolated motor temperature sensing.
- Single system 24 Vdc control voltage.
- Thyristor controlled DC Bus charging.
- DC Bus voltage and current monitoring with short circuit shutdown protection.
- External regeneration resistor checking.

AMD5x Drives equipped with an optional IO Interface which provide the following features:

- 8 Digital Inputs
- 2 High Speed Digital Outputs
- 2 General Purpose Digital Outputs
- 2 Analog Inputs, 1 Analog Output

AMD5x Drives equipped with an optional encoder interface which provide the following features:

- 1 Hiperface DSL Encoder
- 1 BiSS Encoder

3.3 AMD5x Variant Identification

Table 2: AMD5x Variant Identification		
Duct Mount		
PIU	**Drive**	**Capacitor Module**
		
Wall Mount		
PIU	**Drive**	**Capacitor Module**
		
Recessed Mount		
PIU	**Drive**	**Capacitor Module**
		

3.4 Operating Principle

The simplified diagram of the AMD5x control is shown below. The 3 phase AC supply voltage is converted to DC, which is then distributed via a bus to each Drive. The number of drives is chosen by the customer. Each drive converts the DC into the required variable frequency AC voltage signal to drive each motor.

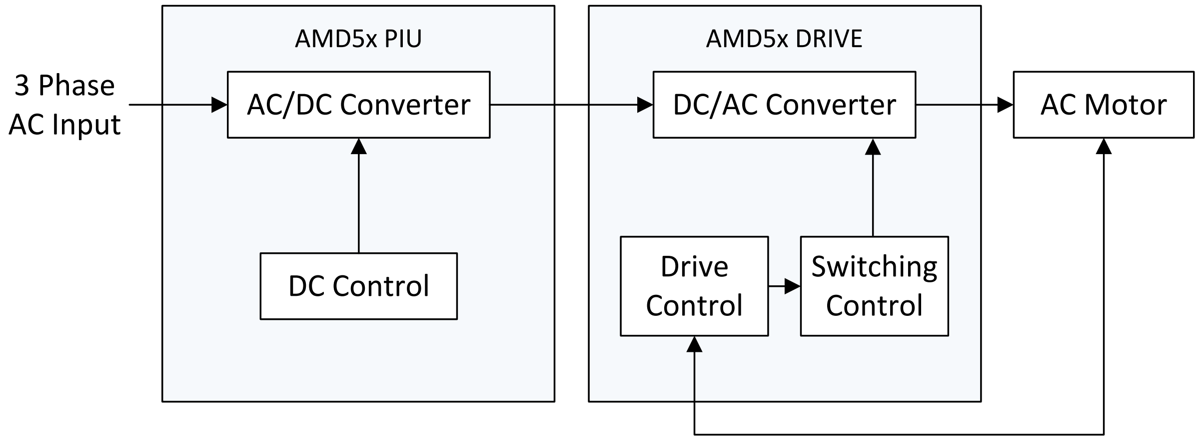


Figure 3-1: AMD5x PIU and Drive operating principle

3.5 System Overview

The AMD5x system comprises one PIU, and one or more digital servo drives as shown in the following figure:

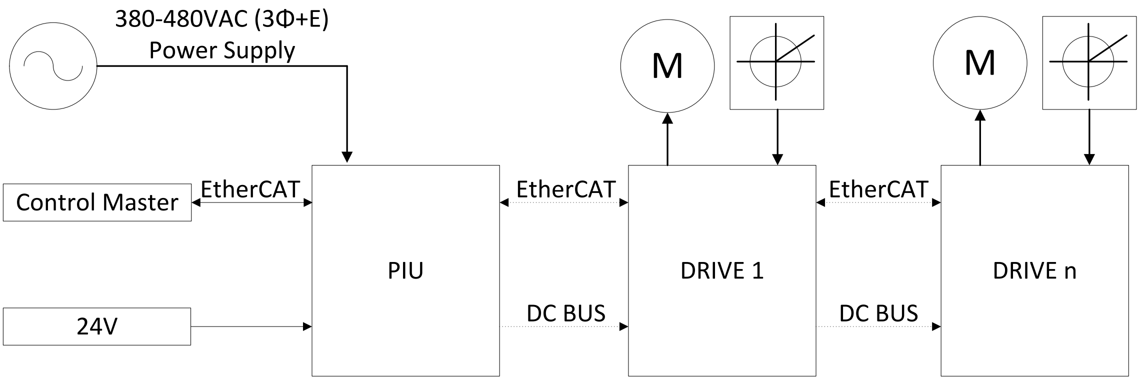


Figure 3-2: AMD5x PIU and Drive system overview

Above example is of a PIU and Drive system supplied from 3 phase mains connection and 24 Vdc supply. Motion control commands are received from a control master system, such as a CNC in the form of structured position commands.

3.5.1 PIU

The Passive Infeed Unit (PIU) primary function is to convert 3 phase mains into a filtered DC supply which is then distributed to the servo drives. The PIU also distributes the customer supplied 24 Vdc control voltage to all drives, and connects the EtherCAT master device to the PIU and Drive system. The PIU external connections are shown in *Figure 3-3.*

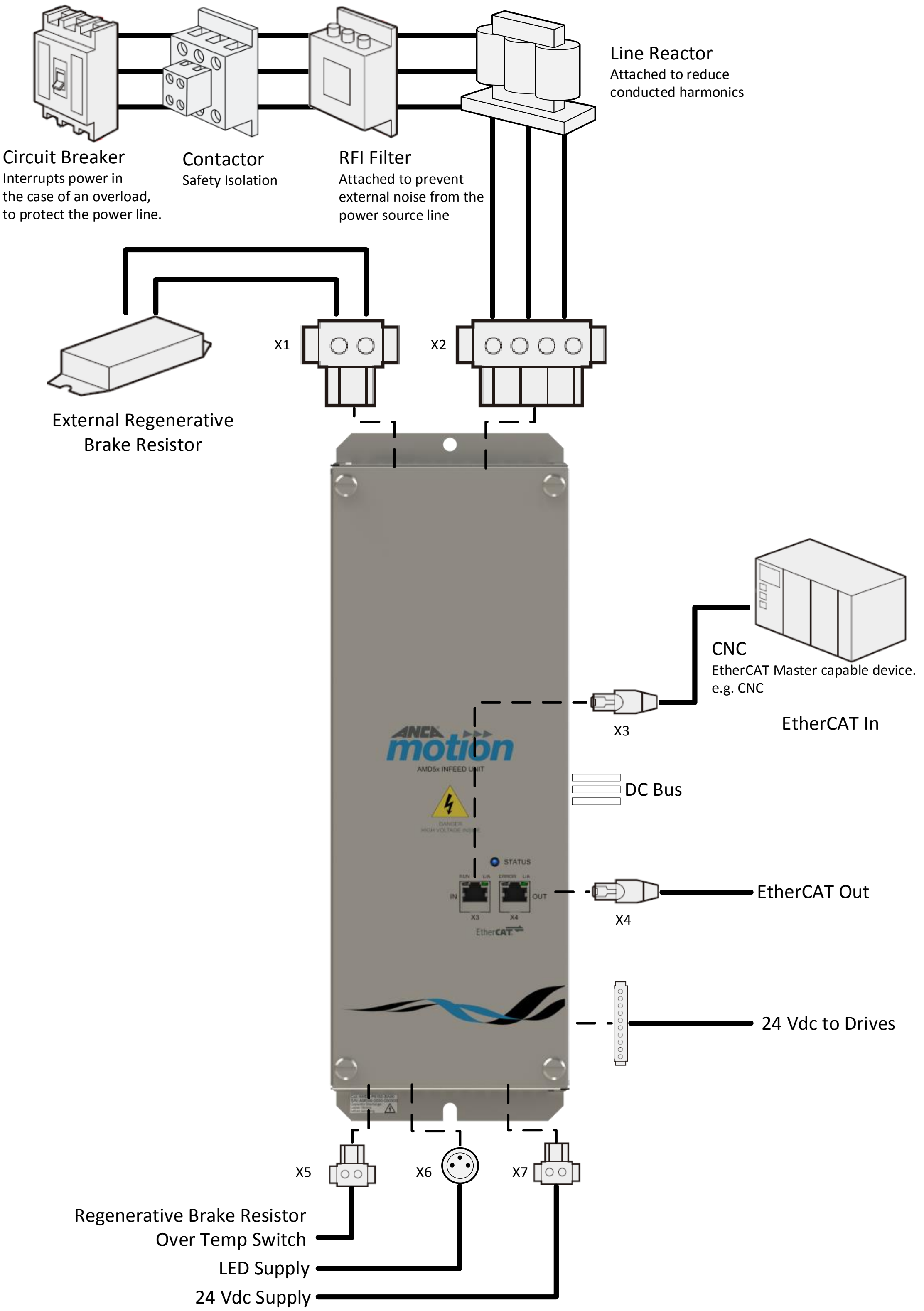


Figure 3-3: PIU system overview

3.6 PIU Connector Overview

The top view of the AMD5x PIU is shown in *Figure 3-4.*

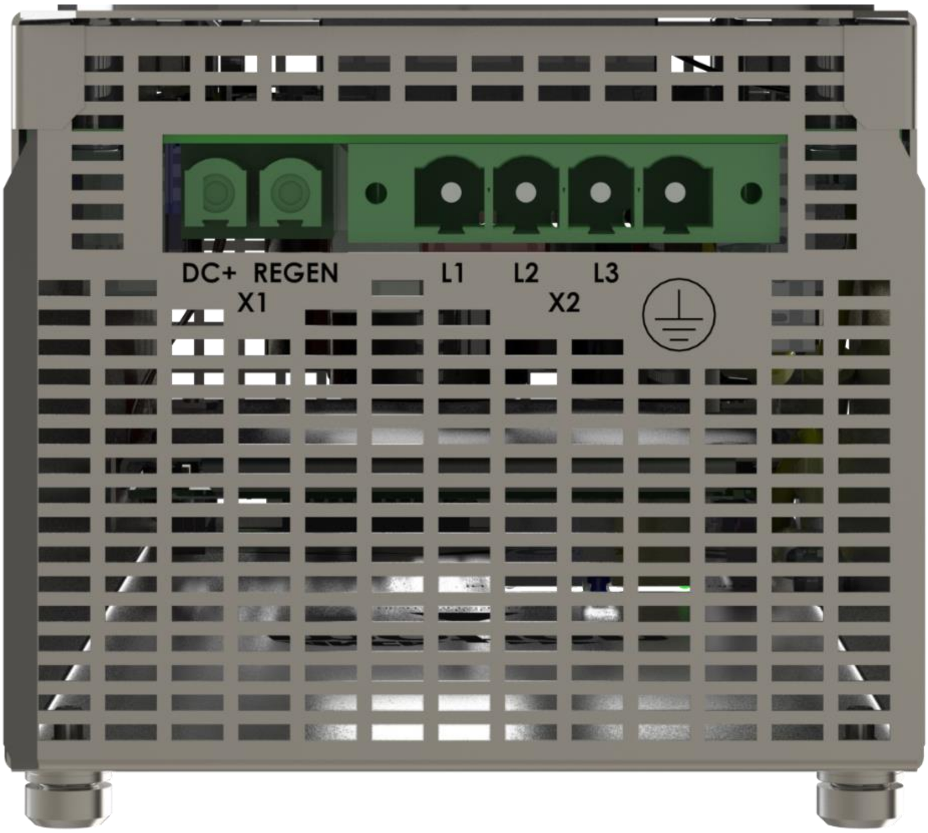


Figure 3-4: Regenerative Brake Resistor (X1) and 3 Phase Mains + Earth Supply (X2)

The bottom view of the AMD5x PIU is shown in *Figure 3-5.*

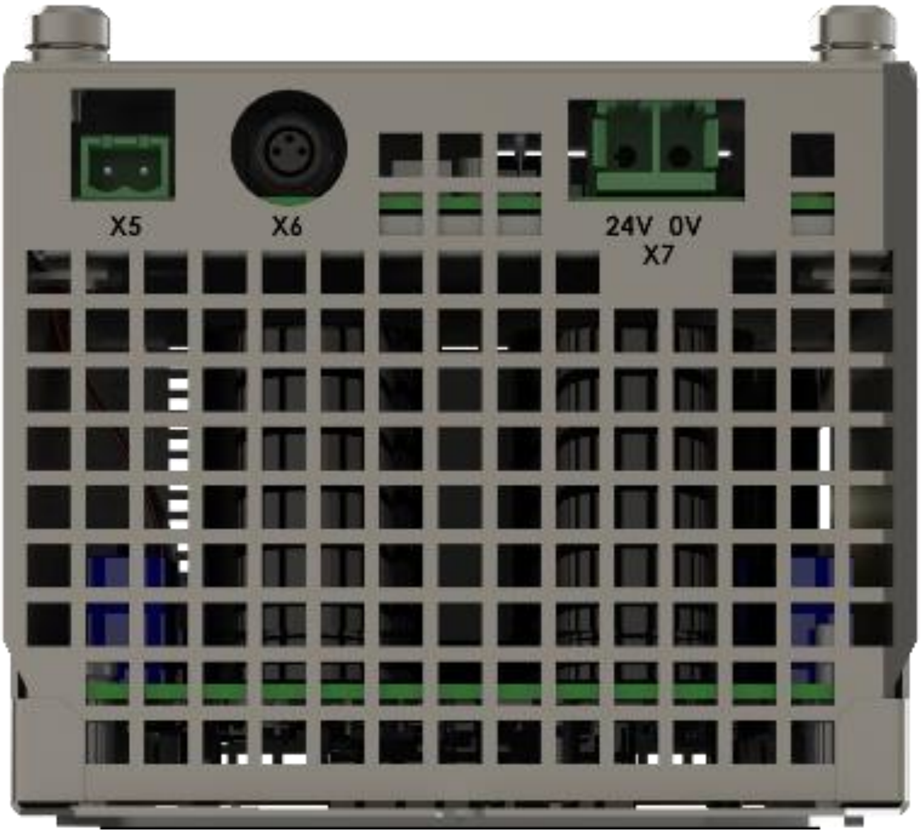
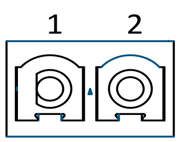


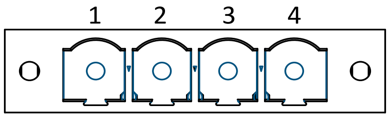
Figure 3-5: Digital Input (X5), LED Supply (X6), and 24 Vdc Supply (X7)

3.6.1 X1 – Regenerative Brake Resistor

Table 3: Regenerative Brake Resistor				
Connector	**Function**	**Pin Assignment (Looking at top of PIU)**	**Pin Number**	**Label**
X1	Connects Regenerative Output to customer resistor		1	DC+
			2	REGEN_OUT

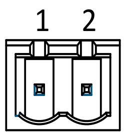
Mating Connector: Phoenix Plug 1969373, ANCA Part Number: ICN-3077-1670

3.6.2 X2 – 3 Phase Mains + Earth Supply

Table 4: 3 Phase Mains + Earth Supply				
Connector	**Function**	**Pin Assignment (Looking at top of PIU)**	**Pin Number**	**Label**
X2	Connects customer three phase supply + protective earth		1	Mains Phase L1
			2	Mains Phase L2
			3	Mains Phase L3
			4	Protective Earth

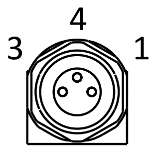
Mating Connector: Phoenix Plug (no locks) 1967391, ANCA Part Number: ICN-3077-1252

3.6.3 X5 – Regenerative Brake Resistor Over-Temperature Switch

Table 5: Digital Input				
Connector	**Function**	**Pin Assignment (Looking at bottom of PIU)**	**Pin Number**	**Label**
X5	Switch Input (N/C). 24 Vdc system		1	SWITCH_RETURN
			2	SWITCH_24 VDC

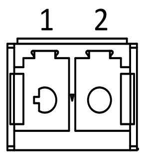
Mating Connector: Phoenix Plug 1910351, ANCA Part Number: ICN-3077-0875

3.6.4 X6 – LED Supply

Table 6: LED Supply				
Connector	**Function**	**Pin Assignment**	**Pin Number**	**Label**
X6	Provides EtherCAT brightness control for customer LED ring		1	LED OUT -
			3	LED OUT +
			4	N/C
			Case	SHIELD

Mating Connector: Binder M8, Series 718 or 768 Male Plugs

3.6.5 X7 – 24 Vdc Supply

Table 7: 24 Vdc Supply				
Connector	**Function**	**Pin Assignment (Looking at bottom of PIU)**	**Pin Number**	**Label**
X7	Connects customer 24 Vdc supply to PIU and Drives. 0V is earthed internally.		1	+24 VDC_SUPPLY
			2	0VDC_SUPPLY

Mating Connector: Phoenix Plug 1778065, ANCA Part Number: ICN-3077-1669

3.6.6 X3 & X4 – EtherCAT Ports

Table 8: EtherCAT Ports (X3 & X4)			
Connector	**Designator**	**Function**	**Mating Connector**
RJ-45	X3	EtherCAT Input connection	EtherCAT Cable, see *6.4.2.3 EtherCAT Cables*
RJ-45	X4	EtherCAT Output connection	EtherCAT Cable, see *6.4.2.3 EtherCAT Cables*

3.7 Drive Connector Overview

The top view of the AMD5x Drive is shown in *Figure 3-6*

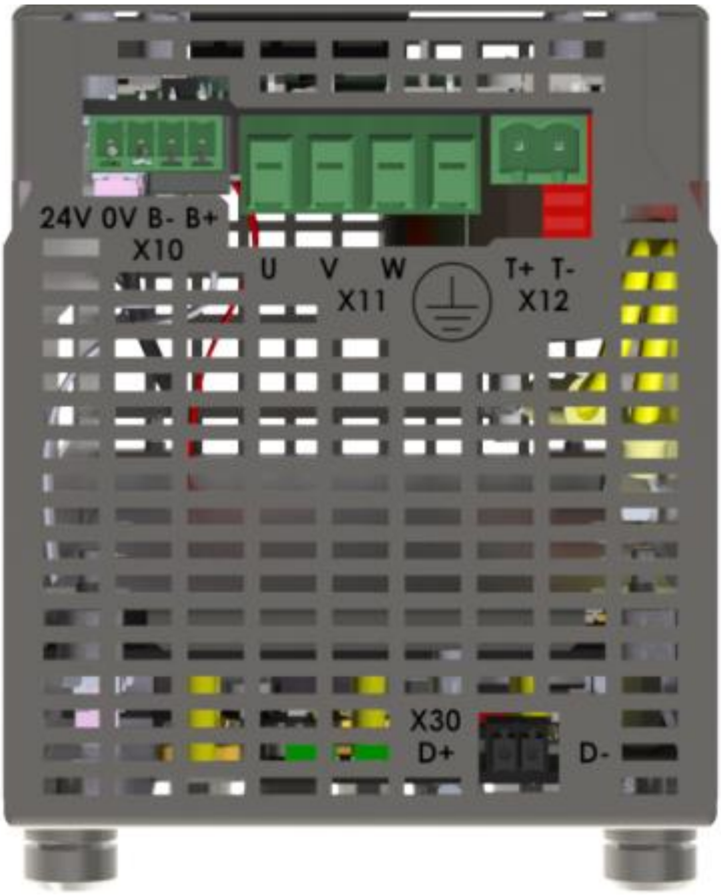
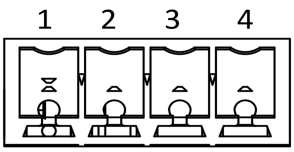


Figure 3-6: 24 Vdc Brake Connections (X10), 3 Phase Armature Supply (X11), Motor Temperature Sensor Input (X12) and Hiperface DSL Interface (X30)

The front view of the AMD5x Drive is shown in *Figure 3-7.*

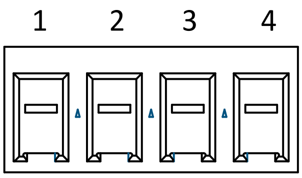
Figure 3-7: Encoder Inputs (X13, X14), Probe Input (X15), Encoder CH1 Monitor Output (X16), EtherCAT In (X17), EtherCAT Out (X18), BiSS Encoder Monitor Output (X31) and BiSS/ABZ Encoder Input (X32)

3.7.1 X10 – 24 Vdc Brake Connections

Table 9: 24 Vdc Brake Connections				
Connector	**Function**	**Pin Assignment (Looking at top of Drive)**	**Pin Number**	**Label**
X10	Connects to Motor Brake Circuit		1	+24 Vdc IN
			2	0V IN
			3	BRAKE -
			4	BRAKE +

Mating Connector: Phoenix Plug Female 1851067, ANCA Part Number: ICN-3077-0896

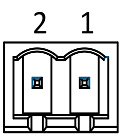
3.7.2 X11 – 3 Phase Armature Supply

Table 10: 3 Phase Armature Supply				
Connector	**Function**	**Pin Assignment (Looking at top of Drive)**	**Pin Number**	**Label**
X11	Connects Drive to Motor		1	U
			2	V
			3	W
			4	E

3A, 6A, 12A & 20A Drives Mating Connector: Phoenix Plug Male 1709063, ANCA Part Number: ICN-3077-1675

35A Drive Mating Connector: Phoenix Plug Male 1969399, ANCA Part Number: ICN-3077-1732

3.7.3 X12 – Motor Temperature Sensor Input

Table 11: Motor Temperature Sensor Input				
Connector	**Function**	**Pin Assignment (Looking at top of Drive)**	**Pin Number**	**Label**
X12	Connects to Motor Thermistor		1	- (KTY84/130 CATHODE)
			2	+ (KTY84/130 ANODE)

Mating Connector: Phoenix Plug Female 1910351, ANCA Part Number: ICN-3077-0875

3.7.4 X13 – Encoder 1 Input

The drive supports 2 channels of 1Vpp encoders on channel 1 (*Figure 3-8*) and channel 2 (*Figure 3-9*).

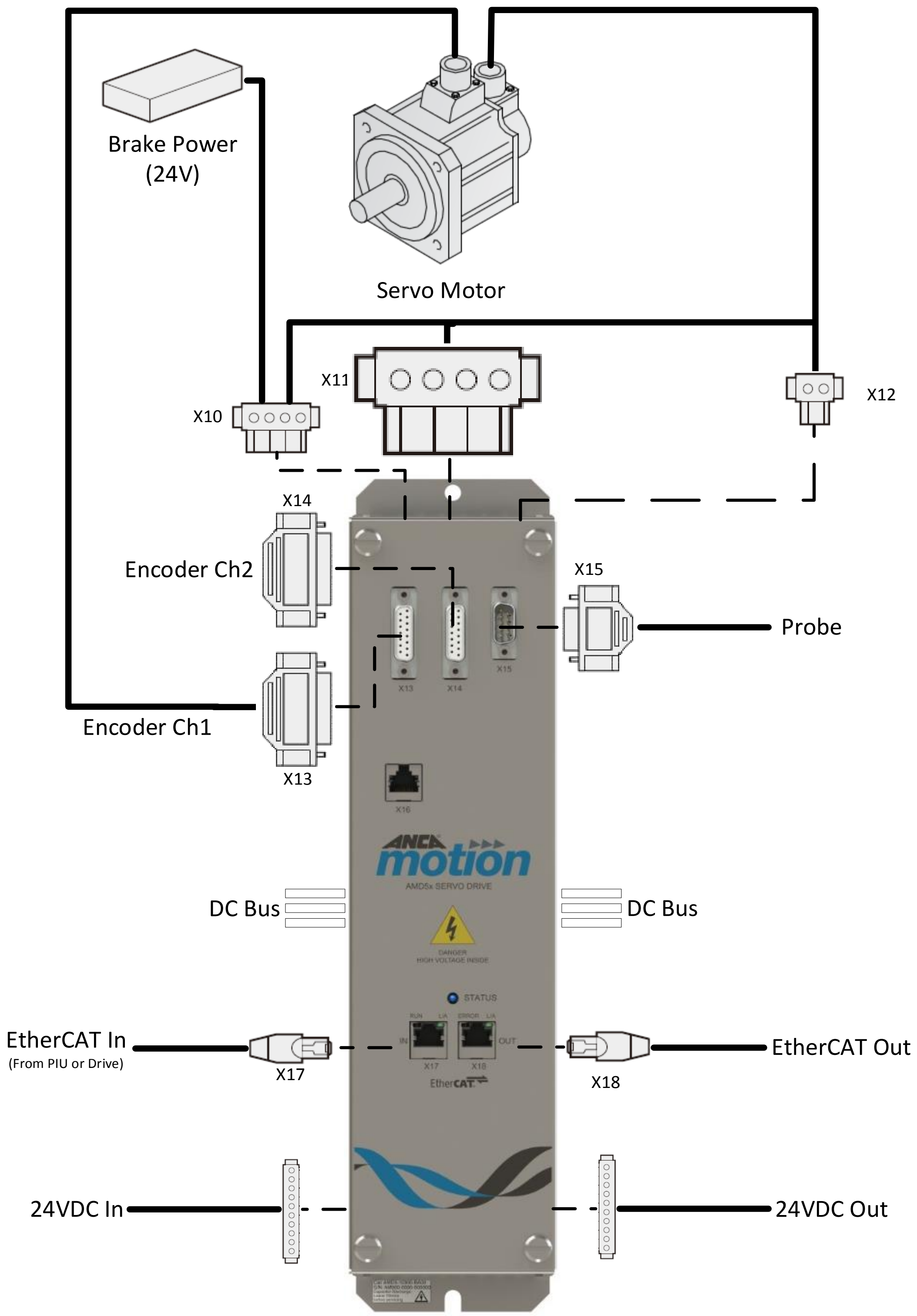
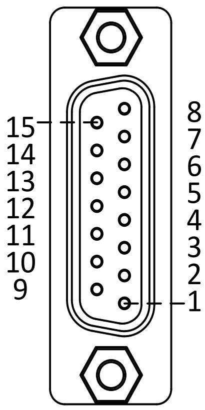


Figure 3-8: Drive System with 1 Vpp Encoder Ch 1

Table 12: Encoder 1 Input				
Connector	**Function**	**Pin Assignment** **(Looking at front of Drive)**	**Pin Number**	**Label**
X13	Connects to 1 Vpp Analog Encoder		1	REF1+
			2	COS1-
			3	COS_COM1-
			4	N/C
			5	N/C
			6	SIN_COM1-
			7	SIN1-
			8	ENC1+5V
			9	REF1-
			10	COS1+
			11	COS_COM1+
			12	SHIELD
			13	SIN_COM1+
			14	SIN1+
			15	ENC1_0V
			CASE	SHIELD

Mating Connector: D-SUB 15-WAY Male with 4-40 UNC jack screws

3.7.5 X14 – Encoder 2 Input

The drive supports 2 channels of 1Vpp encoders on channel 1 (*Figure 3-8*) and channel 2 (*Figure 3-9*).

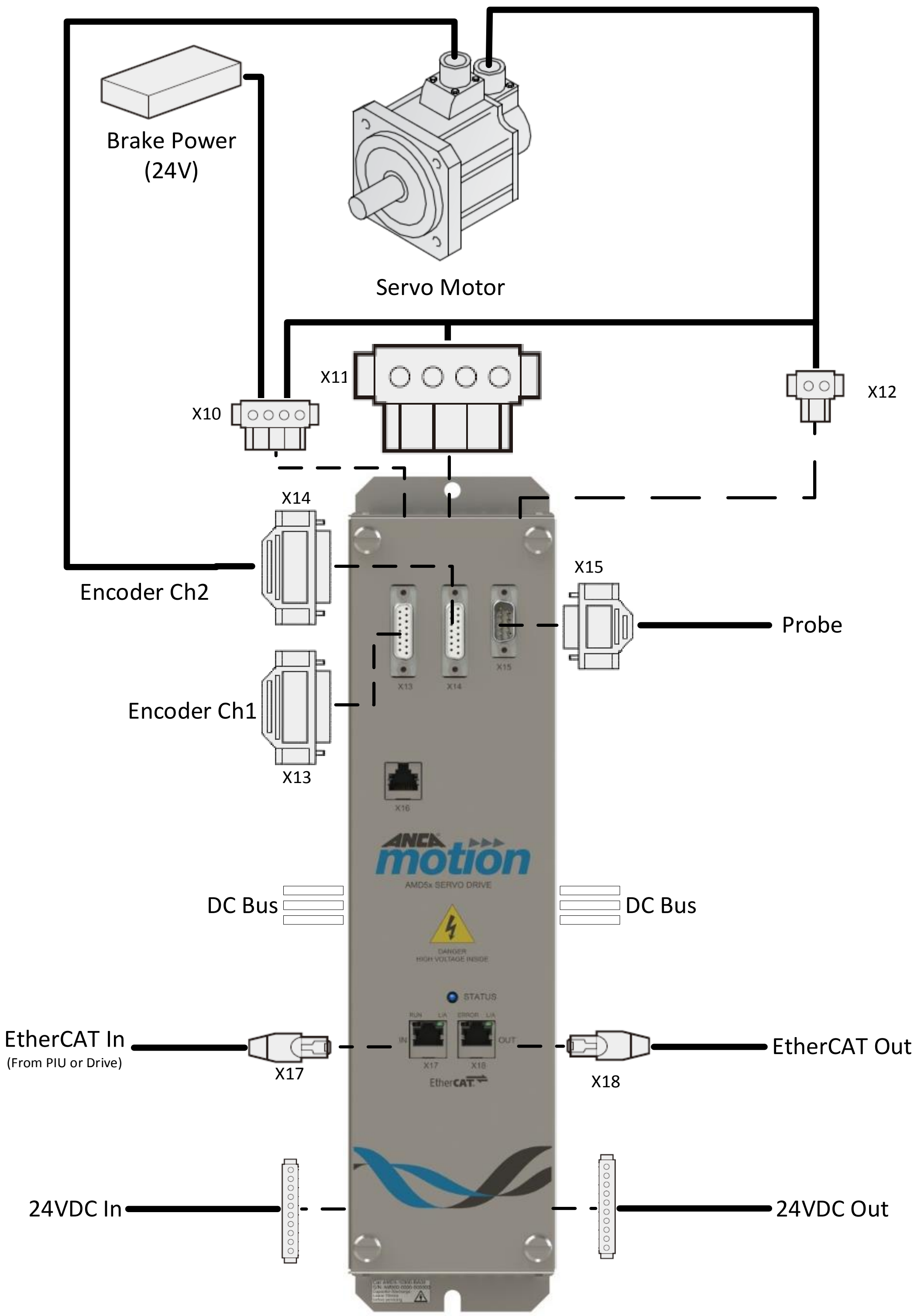
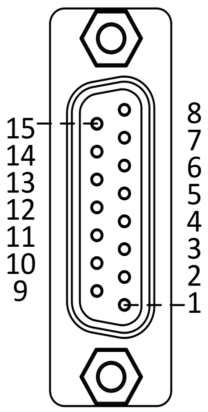


Figure 3-9: Drive System with 1 Vpp Encoder Ch 2

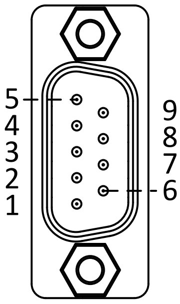
Table 13: Encoder 2 Input

Connector	Function	Pin Assignment (Looking at front of Drive)	Pin Number	Label
X14	Connects to 1 Vpp Analog Encoder		1	REF2+
			2	COS2-
			3	N/C
			4	N/C
			5	N/C
			6	N/C
			7	SIN2-
			8	ENC2+5V
			9	REF2-
			10	COS2+
			11	N/C
			12	SHIELD
			13	N/C
			14	SIN2+
			15	ENC2_0V
			CASE	SHIELD

Mating Connector: D-SUB 15-WAY Male with 4-40 UNC jack screws

3.7.6 X15 – Probe 1&2 Input, ProbeX +24 Vdc Probe/Proxy Feed

Table 14: Probe Input +24 Vdc Probe/Proxy Feed

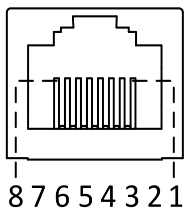
Connector	**Function**	**Pin Assignment** **(Looking at front of Drive)**	**Pin Number**	**Label**
X15	Connects to 2 x Probes, with filtered 24 Vdc output to feed Probe/Proxy		1	PROBE1_INPUT
			2	PROBE1_GND
			3	PROBE1_SHIELD
			4	PROBEX_+24 V
			5	PROBEX_GND
			6	PROBEX_SHIELD
			7	PROBE2_INPUT
			8	PROBE2_GND
			9	PROBE2_SHIELD
			CASE	SHIELD

Mating Connector: D-SUB 9-WAY Female with 4-40 UNC jack screws

3.7.7 X16 – Encoder Monitor Output

The encoder signals can be monitored by an external functional safety device.

Table 15: Encoder 1 Monitor Output

Connector	Function	Pin Assignment (Looking at front of Drive)	Pin Number	Label
X16	Allows external Safety PLC to monitor Encoder 1 Input.		1	GND
			2	N/C
			3	SIN +
			4	SIN -
			5	N/C
			6	COS +
			7	N/C
			8	COS -
			CASE	SHIELD

Mating Connector: 8P8C Plug
Suitable cable: Modified shielded Ethernet cable with twisted pairs to suit X16.

3.7.8 X17 & X18 – EtherCAT® Ports

Table 16: EtherCAT Ports (X17 & X18)

Connector	Designator	Function	Mating Connector
RJ-45	X17	EtherCAT Input connection	EtherCAT Cable, see *6.4.2.3 EtherCAT Cables*
RJ-45	X18	EtherCAT Output connection	EtherCAT Cable, see *6.4.2.3 EtherCAT Cables*

Suitable cables:
KXE-1100-0002 Ethernet Cable Cat 5e SF/UTP 200mm (QTY 1 supplied with Drive)
KXE-1100-0010 Shielded Ethernet Cable Cat 5e SF/UTP 1 metre
KXE-1100-0015 Shielded Ethernet Cable Cat 5e SF/UTP 1.5 metres
KXE-1100-0030 Shielded Ethernet Cable Cat 5e SF/UTP 3 metres
KXE-1100-0050 Shielded Ethernet Cable Cat 5e SF/UTP 5 metres

3.7.9 X30 – Hiperface DSL Encoder Interface

Typical drive with Hiperface DSL encoder is shown in *Figure 3-10*

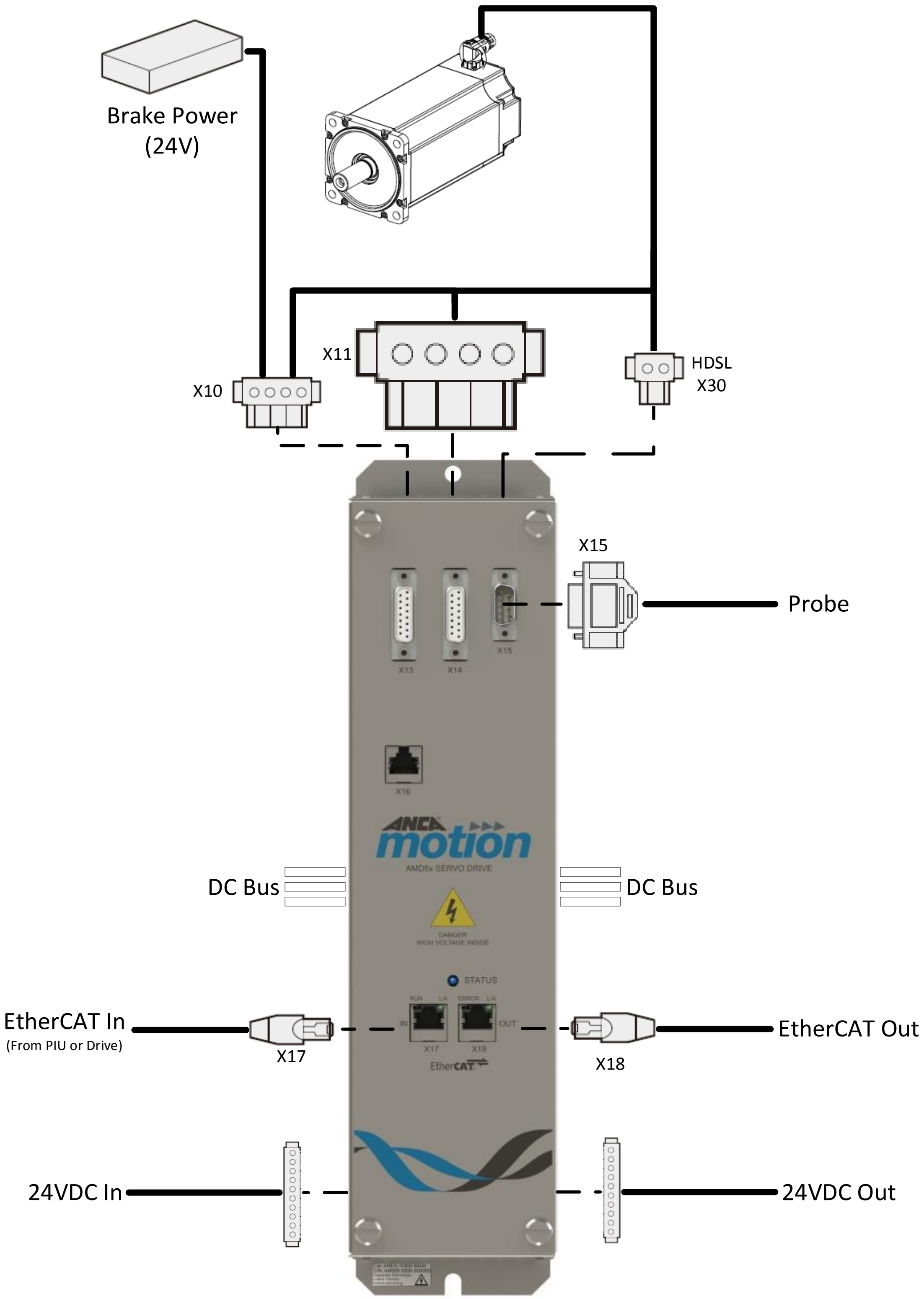
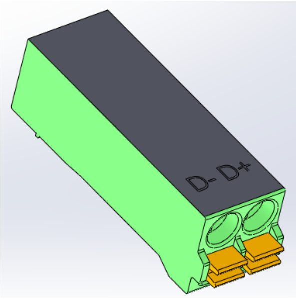


Figure 3-10: Drive system with Hiperface DSL Encoder

Table 17: Hiperface DSL Encoder Interface			
Connector	**Pin Assignment (Connector)**	**Pin Label**	**Function**
X30		D+	DC Supply: Positive Data Pair: Positive
		D-	DC Supply: Ground (0 Vdc) Data Pair: Negative

The Hiperface DSL Encoder Interface is accessed via a single, pluggable connector (X30) on the top face of the Servo Drive, which includes integral polarisation.

The connector-plug has a Spring Cage format and supports the termination of a wire gauge range of 16 – 24 AWG with a wire strip length of 10 mm, or ferrules (including a plastic sleeve) with a cross sectional area range of 0.14 – 0.75 mm^2.

3.7.10 **X32 BiSS/ABZ Encoder Input**

Typical drive with BiSS or ABZ encoder is shown in *Figure 3-11*

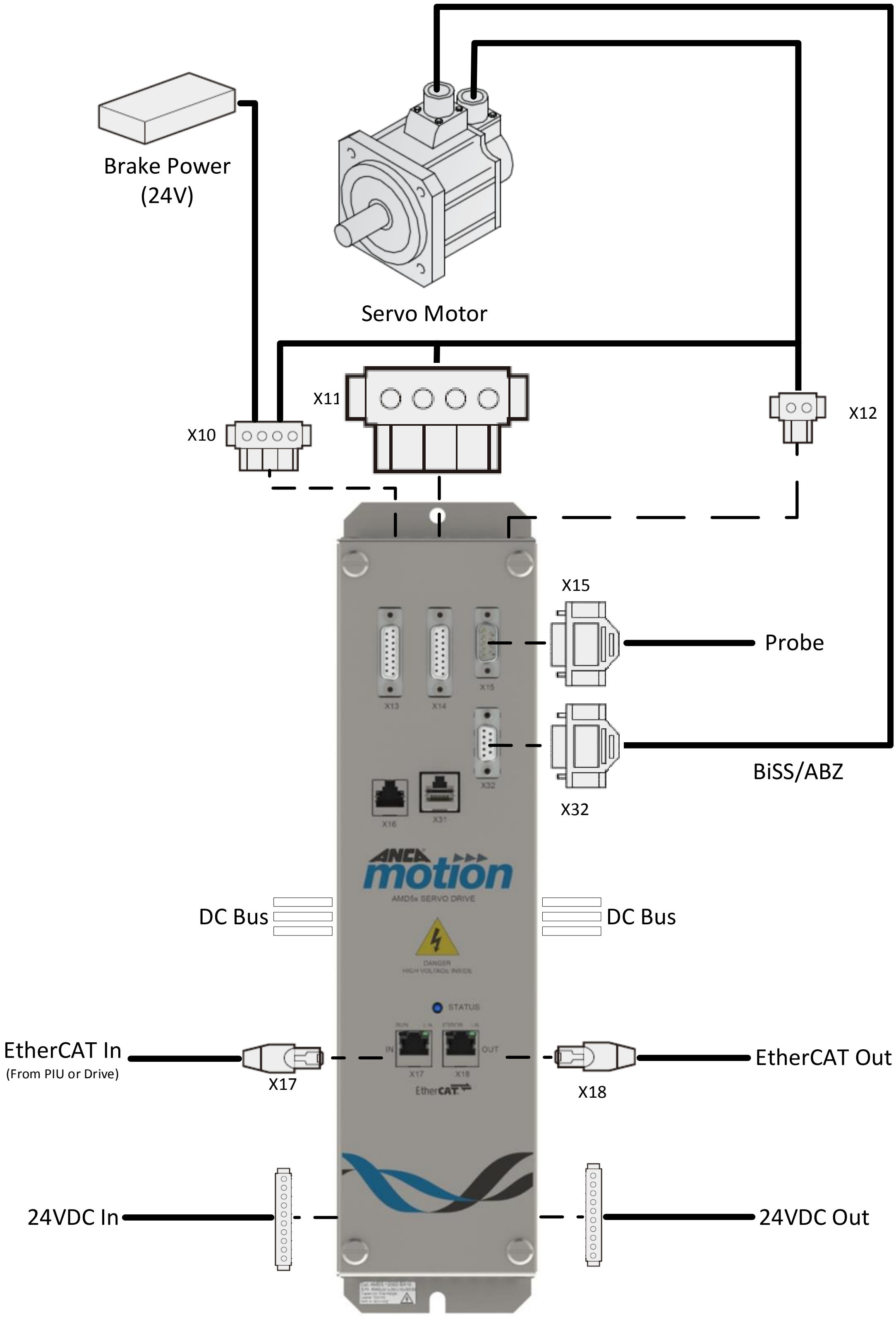
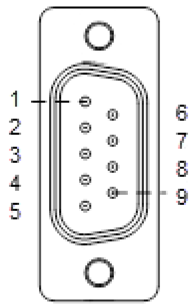


Figure 3-11: BiSS/ABZ System Overview

The BiSS/ABZ Interface consists of one pluggable connector (X32) on the top face of the Servo Drive, which is accessed using one D-Sub 9 pin Male plug, which can be fixed with M4-40 UNC jack screws.

Table 18: BiSS Input

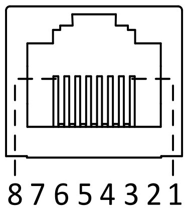
Connector	Function	Pin Assignment (Looking at front of Drive)	Pin Number	Label
X32	Connects to BiSS or ABZ digital encoder		1	BiSS_+5V
			2	BiSS_MA+/A+
			3	BiSS_MA-/A-
			4	BiSS_+5V
			5	BiSS_MO-/Z-
			6	BiSS_+0V
			7	BiSS_SLO+/B+
			8	BiSS_SLO-/B-
			9	BiSS_MO+/Z+
			CASE	SHIELD

Mating Connector: D-SUB 9-WAY Male with 4-40 UNC jack screws

3.7.11 X31 BiSS Encoder Functional Safety Output

The BiSS encoder signals can be monitored by an external functional safety device.

Table 19: BiSS Encoder Monitor Output

Connector	Function	Pin Assignment (Looking at front of Drive)	Pin Number	Label
X31	Allows external Safety PLC to monitor BiSS Encoder with standard 1:1 Shielded Cable.		1	SLO +
			2	SLO -
			3	MA +
			4	N/C-
			5	N/C
			6	MA-
			7	5V
			8	0V
			CASE	SHIELD

Mating Connector: 8P8C Plug
Suitable cables: KXE-1100-0010 Shielded Ethernet Cable Cat 5e SF/UTP 1 metre
KXE-1100-0015 Shielded Ethernet Cable Cat 5e SF/UTP 1.5 metres
KXE-1100-0030 Shielded Ethernet Cable Cat 5e SF/UTP 3 metres

3.7.12 **X20 – IO Interface**

- Connector: X20
- Function: Support interface to IO Interface Subsystems:
  - Digital Input (DI)
  - Digital Output: High Speed (DO-HS)
  - Digital Output: General Purpose (DO-GP)
  - Analog Input (AI)
  - Analog Output (AO)
- Mating Connector: Plug, Spring Cage, Pins: 12, Rows: 1, Pitch: 2.5 mm, Quantity: Two Connectors

Table 20: IO Interface

Pin Number	Connector	Subsystem	Function	Format
1	**X20 Row 1**	DO-HS	External Reference: Positive: +5 to +24 Vdc	Reference
2			Signal: Channel 1	Push-Pull
3			Signal: Channel 2	Push-Pull
4			External Reference: Common Negative: 0 Vdc	Reference
5		AO	External Reference: Negative: 0 Vdc	Reference
6			Signal: Channel 1	SE
7		AI	External Reference: Common Negative: 0 Vdc	Reference
8			Signal: Voltage Interface: Channel 1: P	Differential
9			Signal: Voltage Interface: Channel 1: N	Differential
10			External Reference: Common Negative: 0 Vdc	Reference
11			Signal: Voltage Interface: Channel 2: P	Differential
12			Signal: Voltage Interface: Channel 2: N	Differential
13	**X20 Row 2**	DO-GP	External Reference: Positive: +24 Vdc	Reference
14			Signal: Channel 1	Push-Pull
15			Signal: Channel 2	Push-Pull
16			External Reference: Common Negative: 0 Vdc	Reference
17		DI-GP	Signal: Channel 1	SE
18			Signal: Channel 2	SE
19			Signal: Channel 3	SE
20			Signal: Channel 4	SE
21			Signal: Channel 5	SE
22			Signal: Channel 6	SE
23			Signal: Channel 7	SE
24			Signal: Channel 8	SE

The pinout of the IO Interface connector-header (X20) is shown in *Figure 3-12* below, as viewed from the front face of the Servo Drive.

Polarisation is provided for each mating connector-plug via the inclusion of factory fitted Coding Keys (Red) on pins 12 and 13 of the IO Interface connector-header (X20); the two supplied connector-plugs are provided with the associated pin keys removed.

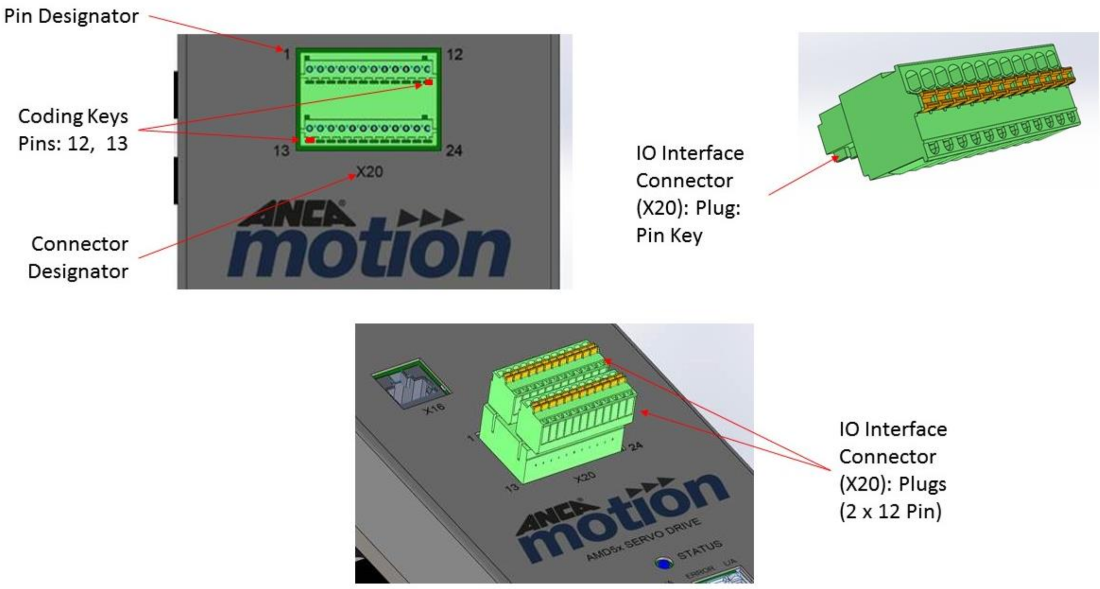
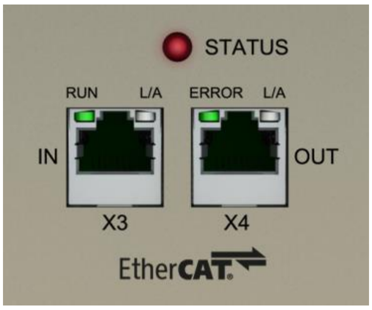


Figure 3-12: AMD5x Drive IO Interface Connector

3.7.13 LED Display and Control Panel - PIU

The AMD5x series PIUs are fitted with a bi-colour status LED as shown in the following figure:

<table>
<tr><th colspan="4">Table 21: LED Display and Control Panel - PIU</th></tr>
<tr><th colspan="2">PIU Display LED Status Blue</th><th colspan="2">PIU Display LED Status Red</th></tr>
<tr><td colspan="2">
</td><td colspan="2">
</td></tr>
<tr><th>LED State</th><th>Definition</th><th>LED State</th><th>Definition</th></tr>
<tr><td>OFF</td><td>No 24 Vdc control supply</td><td rowspan="2">OFF</td><td rowspan="2">No 24 Vdc control supply</td></tr>
<tr><td>Blue: Slow Flash</td><td>DC Bus Not Charged and No PIU Enable Request. AC input is present.</td></tr>
<tr><td>Blue: Fast Flash</td><td>Bus Charging</td><td rowspan="2">Red: Continuous</td><td rowspan="2">PIU Error</td></tr>
<tr><td>Blue: Continuous</td><td>PIU Ready</td></tr>
<tr><td>Red/Blue: Alternating Flash</td><td>DC Bus Not Charged and No PIU Enable Request. AC input is not present.</td><td>Red/Blue: Alternating Flash</td><td>DC Bus Not Charged and No PIU Enable Request. AC input is not present.</td></tr>
</table>

3.7.14 LED Display and Control Panel - Drive

The AMD5x series Drives are fitted with a bi-colour status LED as shown in the following figure:

<table>
<tr><th colspan="4">Table 22: LED Display and Control Panel - Drive</th></tr>
<tr><th colspan="2">Drive Display LED Status Blue</th><th colspan="2">Drive Display LED Status Red</th></tr>
<tr><td colspan="2">
</td><td colspan="2">
</td></tr>
<tr><th>LED State</th><th>Definition</th><th>LED State</th><th>Definition</th></tr>
<tr><td>OFF</td><td>No 24 Vdc control supply</td><td>OFF</td><td>No 24 Vdc control supply</td></tr>
<tr><td>Blue: Flash</td><td>No Error, No Torque On Motor</td><td rowspan="2">Red: Continuous</td><td rowspan="2">Class 1 Diagnostic (C1D) Fault</td></tr>
<tr><td>Blue: Continuous</td><td>No Error, Torque On Motor</td></tr>
<tr><td>Red/Blue: Alternating Flash</td><td>Bypass Mode</td><td>Red/Blue: Alternating Flash</td><td>Bypass Mode</td></tr>
</table>

4 Mechanical Installation

4.1 What This Chapter Contains

This chapter contains information relevant to the mechanical installation of the PIU and drives in an electrical cabinet such as:

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

4.2 Pre Installation Checks

- Prior to installing the drive into the electrical cabinet, check the information on the designation label (located on the side of the drive). Please refer to section *3.3 AMD5x Variant Identification*.
- Check that drive was not damaged during transport. If there are signs of damage the drive may not be safe to use. Please notify shipping agent immediately of the damage and DO NOT install the drive into the electrical cabinet.

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

4.3 Requirements

4.3.1 Installation Site

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

- The AMD5x Series Servo Drive, PIU and Capacitor Module must be permanently fixed in an enclosed electrical cabinet and fitted by trained, qualified personnel. The electrical cabinet must be designed to provide access protection, with access only possible with a use of a tool or after de-energization of the live parts.
- Refer to the *4.3.2 Mounting* for the correct installation process.
- The safety precautions outlined in *1 Safety* must be understood and adhered to.
- The operating environment must not contain corrosive substances, metal particles, dust, flammable substances or gases.
- Ensure that there are no devices mounted adjacent to the drives or PIU that produce magnetic fields which cause heating or electronic interference.
- The maximum recommended operating altitude is 1000m above sea level. Consult ANCA Motion for ratings at higher altitudes.
- The AMD5x must be installed in a cabinet or enclosure of rating IP54 or higher. Higher IP ratings may be required depending on application.
- Avoid any rework of the electrical cabinet / gear tray whilst the drive system is installed. Care must be taken not to install small components directly above the drive system to avoid small parts from falling into the heatsink.
- The electrical cabinet and gear tray must be designed to suit either the Duct, Wall or Recessed Mount variants. It is not possible to interchange these units as the height of the busbars and or heatsink hole cut outs in the gear tray will be affected.

- Design of the cabinet should reference the mechanical drawings in *10.6 Dimension Drawings.*

4.3.2 Mounting

- The AMD5x must be installed vertically (see *4.4 Installation* for installation process).
- Both the drives and PIU are intended to be mounted in electrical cabinets and it is the responsibility of the installer to ensure the drives are earthed through the provided protected earth points denoted with the ⏚ symbol.
- The AMD5x series drives should be mounted on a zinc plated steel or Aluminium panel. Painted panels are not to be used.
- If any AMD5x 35A (125mm wide) drives are to be installed, these must be mounted adjacent to the PIU. All 24 Vdc ribbon cable configurations require this installation method. Refer *11.4 24 Vdc Ribbon Cable.*
- If any AMD5x Capacitor Modules are to be installed, these must be mounted furthest away from the PIU, after all Drives. The 24 Vdc ribbon cable does not pass through the Capacitor Modules.

Warning: During operation, the AMD5x Regenerative Brake Resistor and heat sink mounting surfaces can reach above +90°C depending on load. Care must be taken to avoid burns or injury.

Ensure that the gear tray mounting surface is free from all combustible materials and vapours.

4.3.3 Drive Array Mounting Options and Benefits

There are three drive array mounting options available. Below is a list of these mounting options with a brief explanation including their benefits.

Option Number	Drive Array Mounting Options	Variations	Brief Explanation and Benefits of each mounting option
1	Duct Mount	External cooling fan system	External fans mounted at one end of a cooling duct (located directly behind the electrical cabinet) are used to force the factory air to cool the heatsinks in the array. This heated air from the combined heatsinks then exits at the other end of the duct back into the factory. Refer to *4.3.4 Heatsink Cooling with External Cabinet Air Using Duct Mount Fitment* for more details The benefits of this system are: • The heatsinks in the array are cooled external to the electrical cabinet, which means that the operating conditions inside are not affected.
		Internal cooling fan system	Fans mounted to a cooling duct inside the electrical cabinet are used to force the air to cool the heatsinks in the array. This heated air from the combined heatsinks then exists the duct and is then recirculated inside the electrical cabinet. Refer to *4.3.5 Heatsink Cooling with Internal Cabinet Air Using Duct Mount Fitment* for more details The benefits of this system are: • The drive array is installed entirely within the electrical cabinet and does not require an external duct.
2	Wall Mount		The entire Drive Array system is mounted on the gear tray. Each PIU and Drive's heatsink in the array will be independently cooled. Refer to *4.3.7 Heatsink Cooling - Wall Mount Fitment* for more details. The Drive array depth has increased by +45mm due to the fan and heatsink combination. Refer to *10.6.1 15kW and 24kW* PIU Physical Dimensions, *10.6.3 35A and 35AH Drive Mounting Hole Positions and* Physical Dimensions, *10.6.4 3A, 6A, 12A & 20A Drive Mounting Hole Positions and Physical Dimensions* for more details. The benefits of this system are: • No heatsink hole cut outs in the gear tray – PIU and Drives are mounted directly to the gear tray. • Each unit's heatsink can be cooled independently. • The electrical cabinet and machine design is simplified as there is no cooling duct to consider. • No need to remove the PIU or drive to replace fans. Refer to section *4.5 Fan Housing Assembly Replacement* for more details.
3	Recessed Mount		Same description for Wall Mount except the gear tray has a hole cut out to allow the heatsinks to pass through. Refer to *4.3.8 Heatsink Cooling - Recessed Mount Fitment*4.3.8 for more details. The benefits of this system are: • Heatsinks are not visible. • Allows easier maintenance of the internal electrical cabinet operating conditions by moving the majority of the losses to an isolated area behind the gear tray. Refer to *10.5.3 Installation and Operation* for more details

4.3.4 Heatsink Cooling with External Cabinet Air Using Duct Mount Fitment

The AMD5x PIU and Drives utilise a duct mounting system where the heatsinks project though the gear tray cut-outs into a cooling duct which can be supplied with air external to the cabinet (see *Figure 4-1* and *Figure* 4-2). The cool air is drawn from the fan entry and then passed over the PIU and Drive heatsinks. This allows heat from the heatsinks to be separated from the main cabinet enclosure, thus reducing cabinet cooling requirements and cabinet pollution.

As per table *10.5.4 Duct Mount Cooling*, heatsink losses are the major power losses from the PIU and Drives, and it is preferable to dissipate this heat into the external environment and not into the cabinet enclosure.

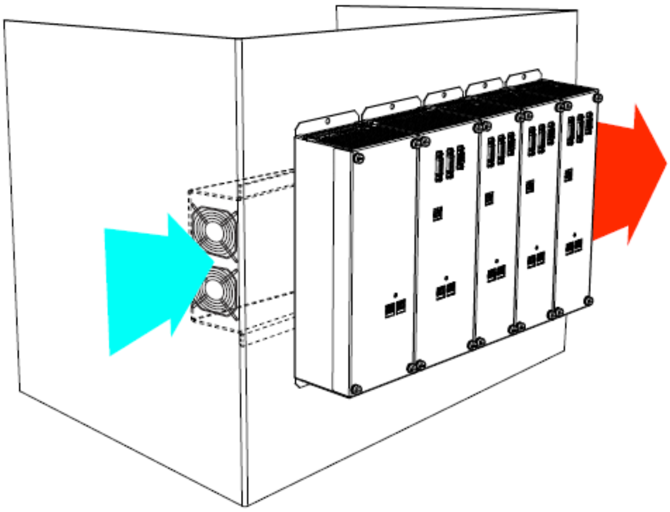


Figure 4-1: AMD5x system with external cabinet air supplying cooling duct

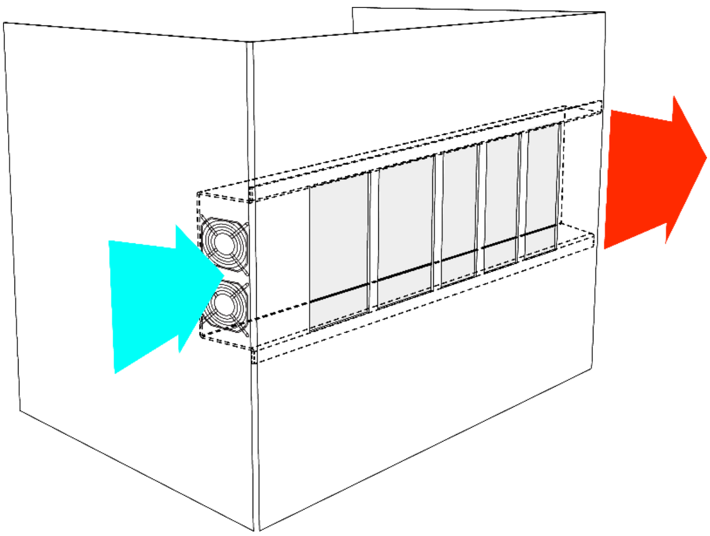


Figure 4-2: AMD5x cooling duct and gear tray with external cabinet air supplying cooling duct

4.3.5 Heatsink Cooling with Internal Cabinet Air Using Duct Mount Fitment

The duct mounted AMD5x PIU and Drives MUST use a duct (air tunnel) which can be installed in a cabinet where the cooling duct air is supplied from internal cabinet air (see *Figure* 4-3). The cool air is drawn from the fan entry and then passed over the PIU and Drive heatsinks and heated air is recirculated back into the cabinet, which is cooled by an air-conditioner or similar active heat dissipation system. The PIU and Drives are mounted on a small gear tray which also supports the cooling duct and fan mounting (see *Figure 4-4)*.

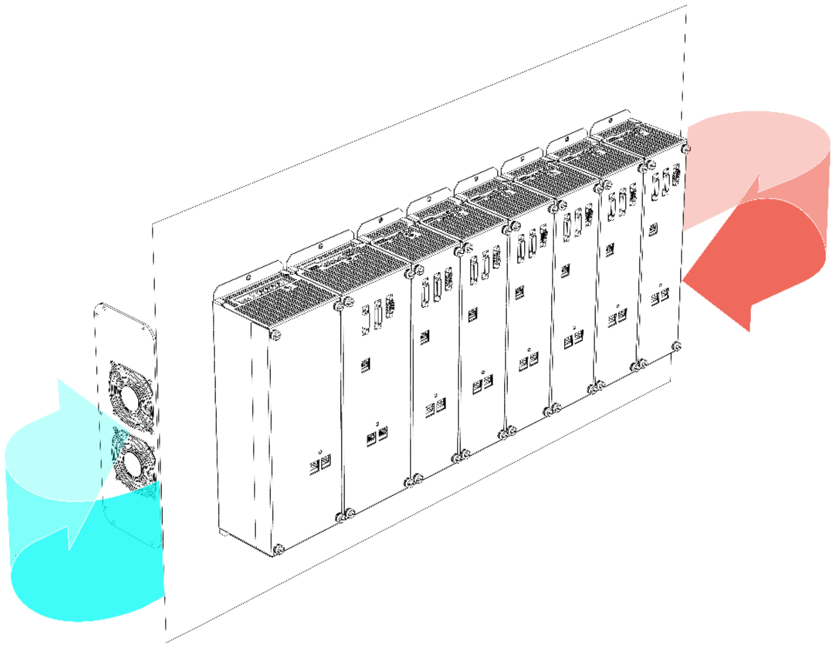


Figure 4-3: AMD5x system with internal cabinet air supplying cooling duct

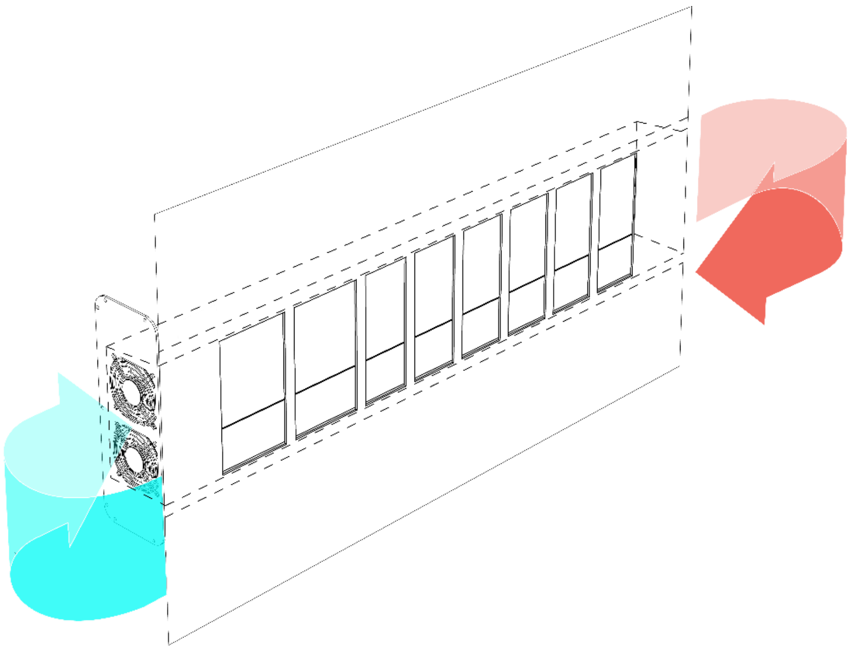


Figure 4-4: AMD5x cooling duct and gear tray with internal cabinet air supplying cooling duct

4.3.6 Example Cooling Duct Design

A suitable cooling duct system can be created with folded sheet-metal as per *Figure 4-5*.

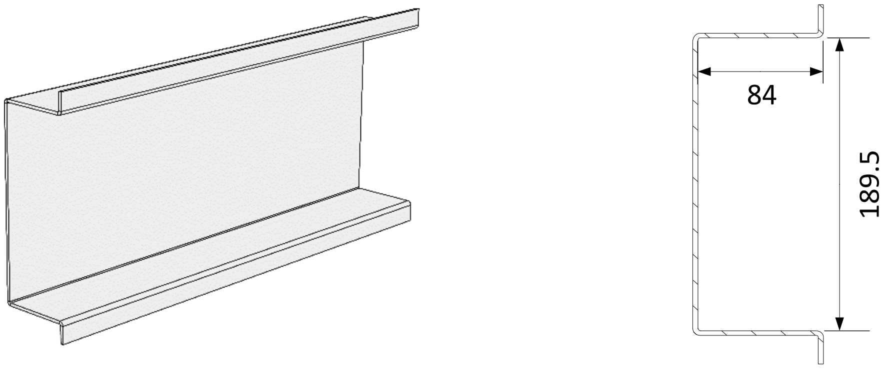


Figure 4-5: Cooling Duct with typical dimensions

The duct must have no air leaks, and is mounted onto the rear of the gear tray with PIU and Drives. Each PIU and Drive has a rubber gasket surrounding the heatsink to provide a seal between the duct and cabinet preventing air from the duct entering the cabinet. Refer to *Figure 4-6* to allow even air flow the duct must extend past the last Drive, and provide 60 to 90mm of space between the fans and PIU heatsink.

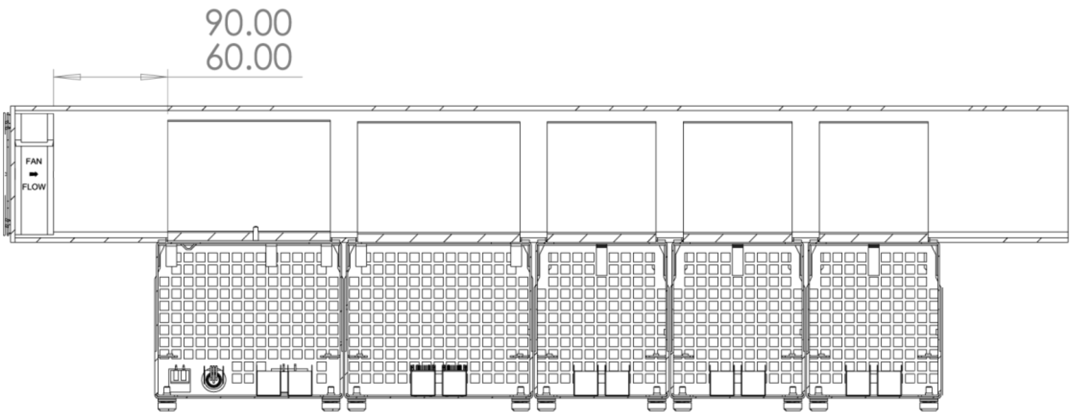


Figure 4-6: AMD5x system fan clearance to first PIU heatsink

Refer to *Figure 4-7* and *Figure 4-8* for side views with duct showing fan and heat sinks

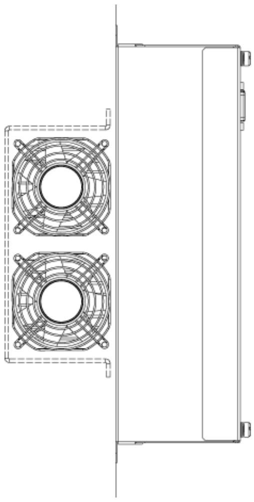


Figure 4-7: Duct exit view

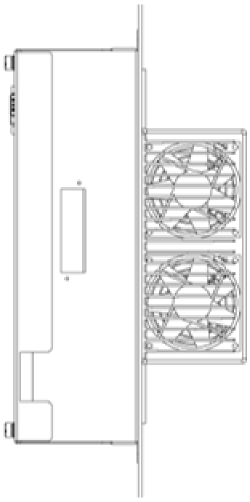


Figure 4-8: Duct entry view

A suitable fan module kit to mount on the duct end can be supplied by ANCA Motion. See *11.6 Cooling Duct Fan Kit.* The two fans should be fitted inside the duct end as per *Figure 4-9,* and sealed to maximise air flow.

For installations using external cabinet air (see *4.3.4 Heatsink Cooling with External Cabinet Air Using Duct Mount Fitment*), the inlet fans can be mounted on inside of the cabinet wall, with outlet protection grills on the outside. The fan cut-out is shown in *Figure 4-9.*

For installations using internal cabinet air (see *4.3.5 Heatsink Cooling with Internal Cabinet Air Using Duct Mount Fitment*), the fans can be mounted on duct end plate with fan cut-out is shown in *Figure 4-9.* The outlet protection grills are optional.

An example of the fan kit, fan cut-out, and cut-out positioning relative to cooling duct is shown in *Figure 4-9.*

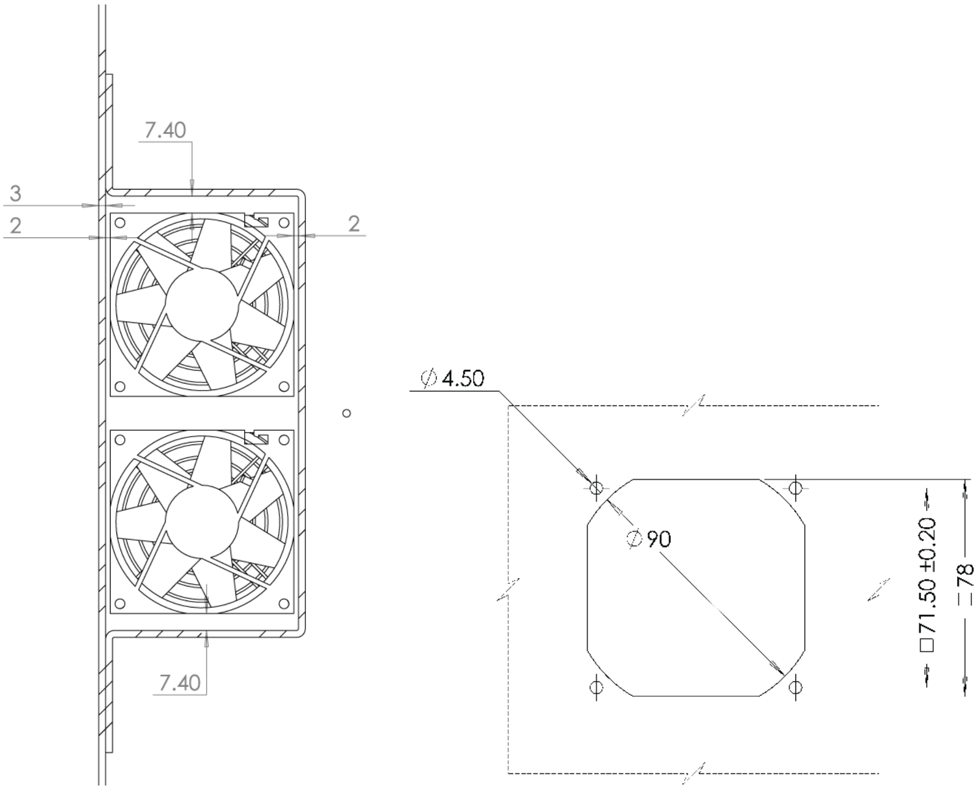


Figure 4-9: AMD5x fan and duct positioning, and fan cut-out

A correctly selected fan kit module and duct design provide sufficient air flow across the drive heatsinks to allow full operation within the acceptable temperature range. If air flow is insufficient the heat sink temperature may increase to the point that the PIU or Drive will signal an error and cease to provide energy to the motor. If the required cooling and air flow requirements are not met, the drive may detect an over temperature condition. The airflow across drive heatsinks will be heated by each preceding drive heatsink in the duct, resulting in duct air temperatures above ambient. The increased air duct temperature may exceed the maximum heat sink temperatures and thus limit maximum drive current. Consult *12.3 Product, Sales and Service Enquiries* for assistance to determine drive current limits when operating drives at high ambient and high continuous load currents.

4.3.7 **Heatsink Cooling - Wall Mount Fitment**

The wall mount AMD5x installation is shown *Figure 4-10*. The cool air is drawn from the fan entry at the bottom of the modules and exits at the top. The user must ensure the environmental conditions inside the cabinet meet the requirements shown in *10.4.4 Temperature Derating* for operating specifications.

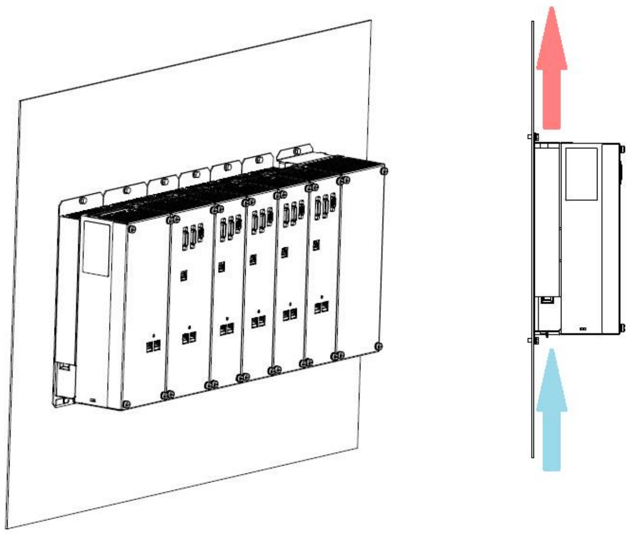


Figure 4-10: AMD5x Wall Mount fitment air flow direction

4.3.8 **Heatsink Cooling - Recessed Mount Fitment**

The recessed mount AMD5x installation is shown *Figure 4-11*. Drives are installed in a cabinet where the individual module heatsinks are recessed behind the gear tray. The user must ensure the environmental conditions on the rear of the gear tray meet the requirements shown in *10.4.4 Temperature Derating* for operating specifications, and that the Heatsink cooling paths are not obstructed in any way.

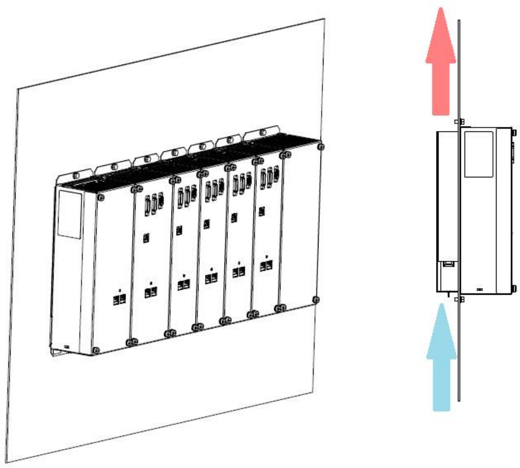


Figure 4-11: AMD5x Recessed Mount fitment air flow direction

4.3.9 **Cabinet Cooling**

When mounting the PIU and Drives inside a sealed electrical cabinet, care should be taken to ensure that the air temperature inside the cabinet remains within the specified temperature limits of table *10.5.3 Installation and Operation.* Care must be taken not to exceed the dew point when the internal electrical cabinet is cooled.

The relative humidity of the air entering the drive system shall be within the specified limits of table *10.5.3 Installation and Operation.*

4.3.9.1 Mounting of Drives for Effective Cooling Inside the Electrical Cabinet:

The AMD5x PIU and drives require 100mm clearance on the top and bottom as shown in *Figure* 4-12, to allow connector access and provide sufficient ventilation. There is no clearance requirement for the sides of PIU provided adjacent equipment does not exceed the product temperature specifications.

Refer to *10.5 Environmental Specifications* for further requirements.

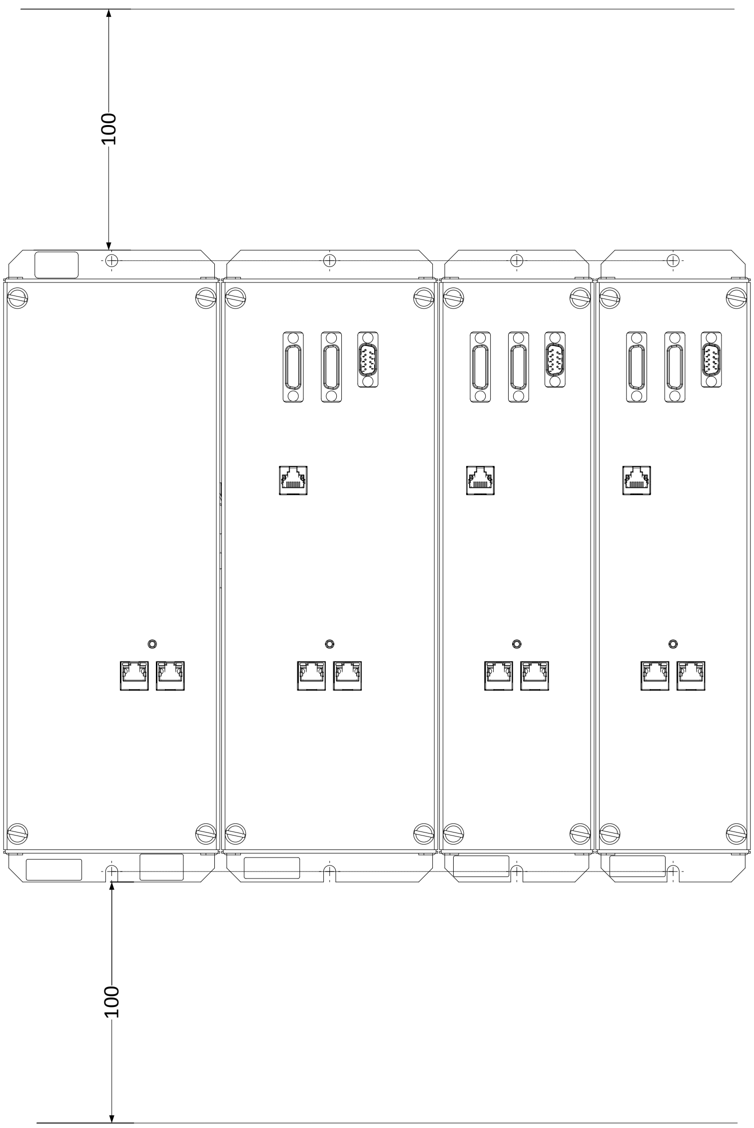


Figure 4-12: Mounting clearance requirements

4.4 Installation

4.4.1 Installation Order

- If any AMD5x 35A or 35AH (125mm wide) Drives are to be installed, these must be mounted adjacent to the PIU. All 24 Vdc ribbon cable configurations are based on this installation order. Refer *11.4 24 Vdc Ribbon Cable*
- If any AMD5x Capacitor Modules are to be installed, these must be mounted furthest away from the PIU, after all Drives. The 24 Vdc ribbon cable does not pass through the Capacitor Modules.

4.4.2 Mounting a PIU

The following sections show the PIU mounting holes for the duct mount (*Figure 4-13*), wall mount (*Figure 4-14*) and recessed mount (*Figure 4-15*) variants.

The installation is intended to insert the bottom screw first, before the PIU is lifted into position. The screw should not be made tight, but screwed with about 5mm of exposed thread exposed. Lift the PIU onto the screw so the screw supports the weight of the PIU in the bottom slot in the chassis then tilt it back into position and install the top mounting screw and tighten both screws to a torque of 3.0 Nm. Refer to *Figure 4-13* and *Figure 4-14*

Uninstalling the product is the reverse of the installation procedure. Ensure mains power has been isolated from the PIU. Refer to *5.3.1 Power Isolation.*

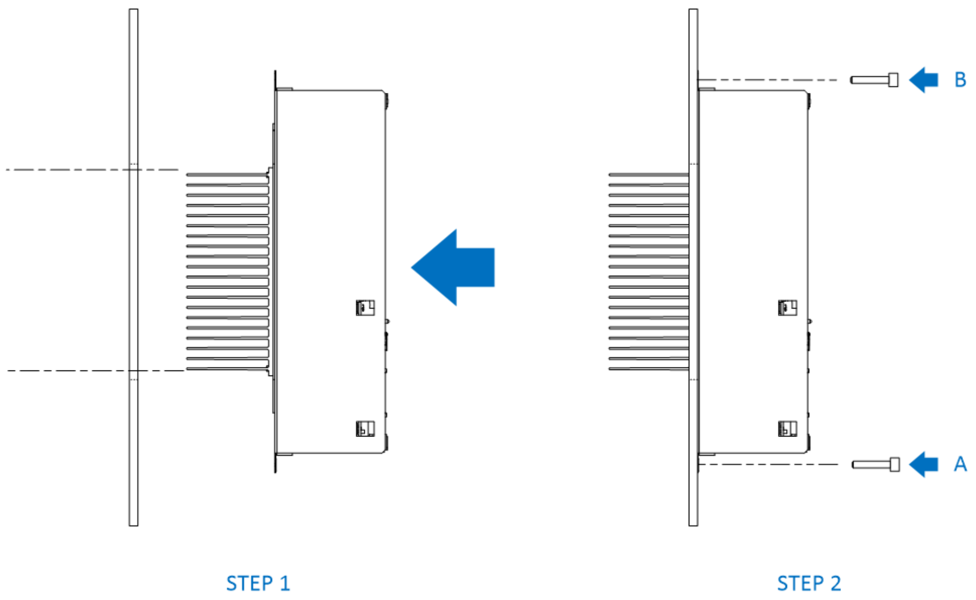


Figure 4-13: Mechanical Mounting of PIU Duct Mount

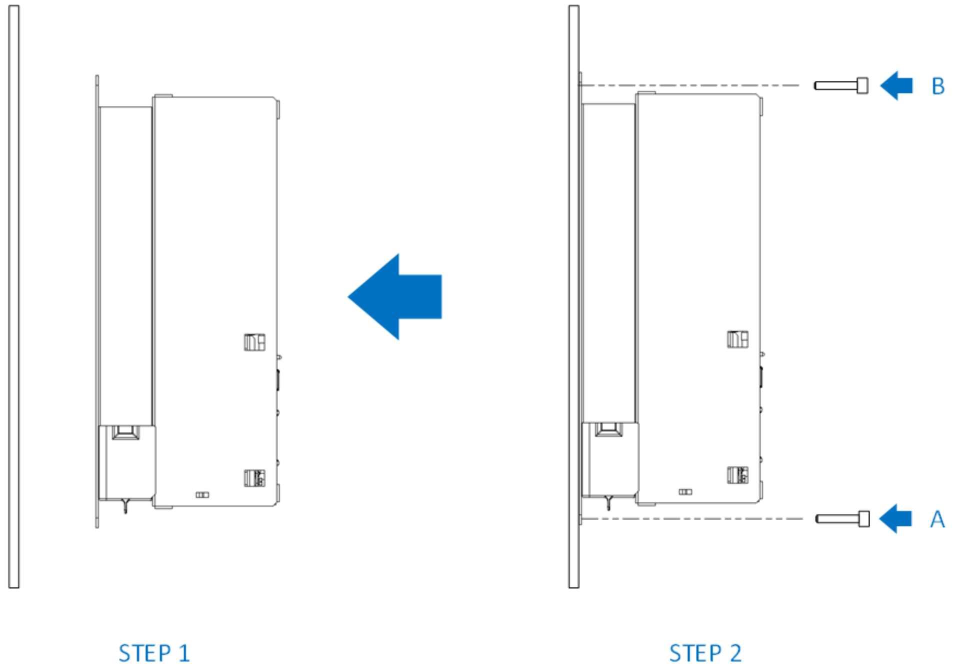


Figure 4-14: Mechanical Mounting of PIU Wall Mount

4.4.2.1 Recessed Mount

When installing the recessed mount PIU, be careful not to damage the pull tabs on the fan housing when the product is inserted into the gear tray slot. Refer to *Figure 4-15*

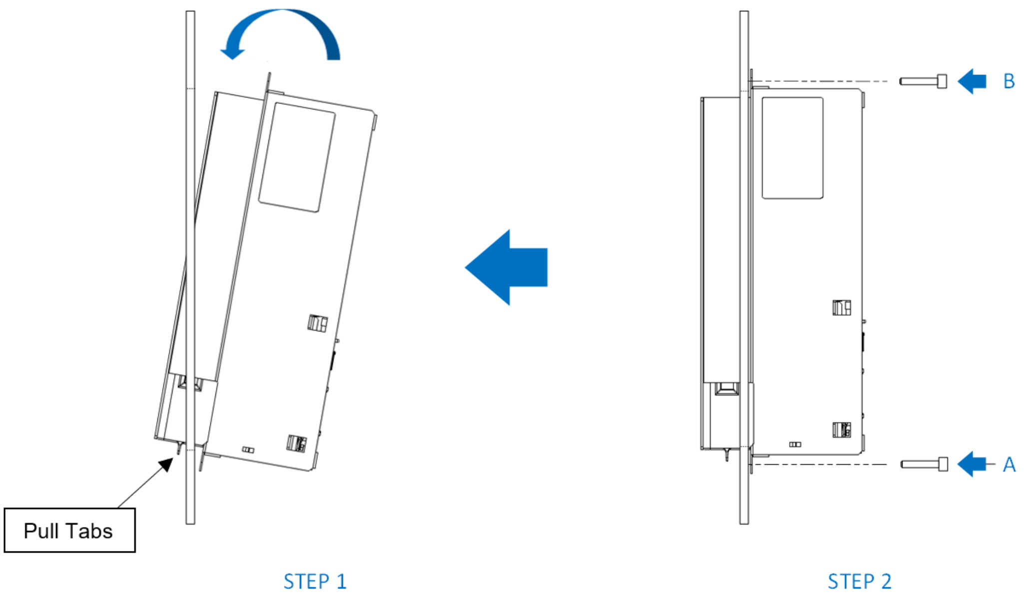


Figure 4-15: Mechanical Mounting of PIU Recessed Mount

4.4.3 Mounting a Drive

The following sections show the drive mounting holes for the Duct mount (*Figure 4-16*), Wall mount (*Figure 4-17*) and Recessed mount (*Figure 4-18*) variants.

The installation is intended to insert the bottom screw first, before the drive is lifted into position. The screw should not be made tight, but screwed with about 5mm of thread exposed. Lift the drive onto the screw so the screw supports the weight of the drive in the bottom slot in the chassis then tilt it back into position and install the top mounting screw and tighten both screws to a torque of 3.0 Nm. Refer to *Figure 4-16*, *Figure 4-17* and *Figure 4-18.*

Uninstalling the product is the reverse of the installation procedure. Ensure mains power has been isolated from the PIU. Refer to *5.3.1 Power Isolation.*

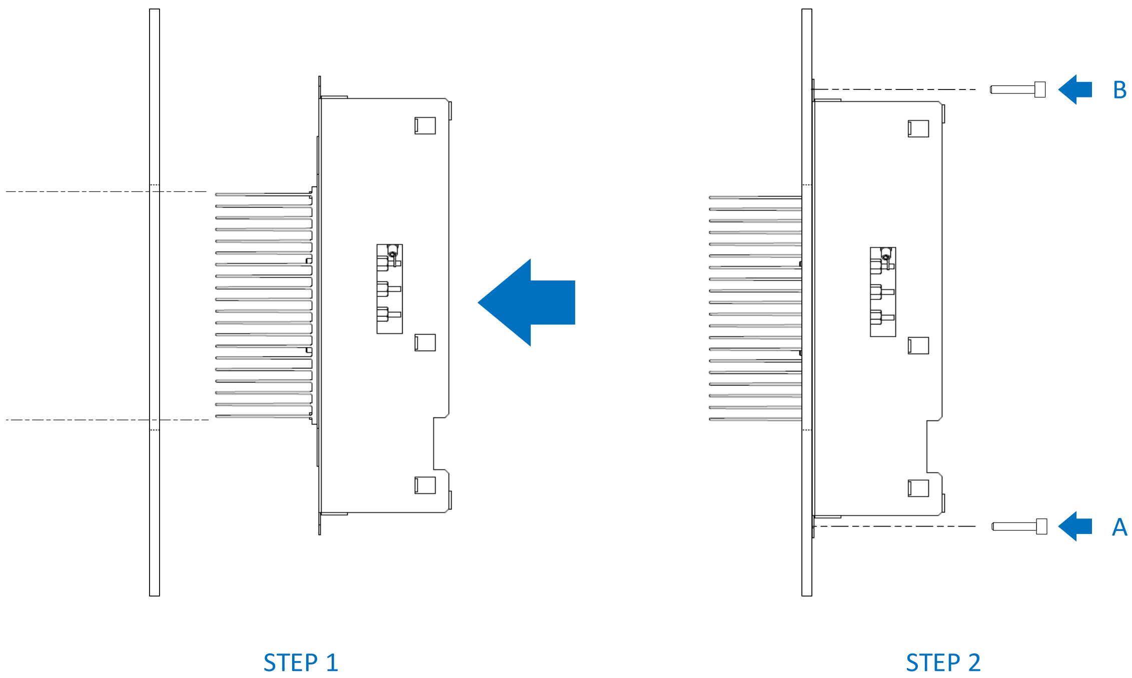


Figure 4-16: Mechanical Mounting of a Drive Duct Mount

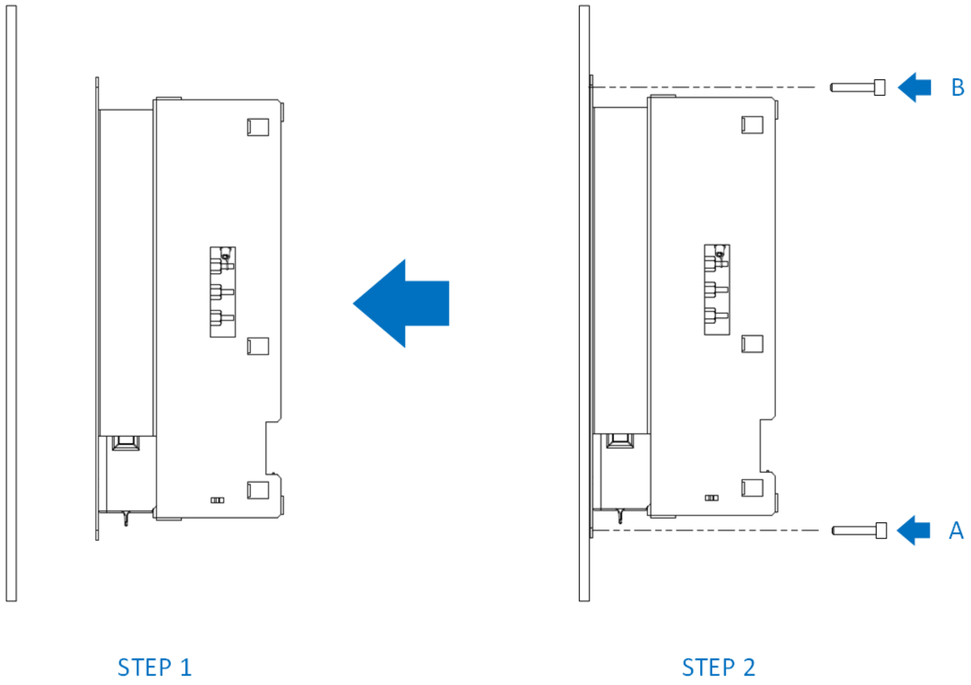


Figure 4-17: Mechanical Mounting of a Drive Wall Mount

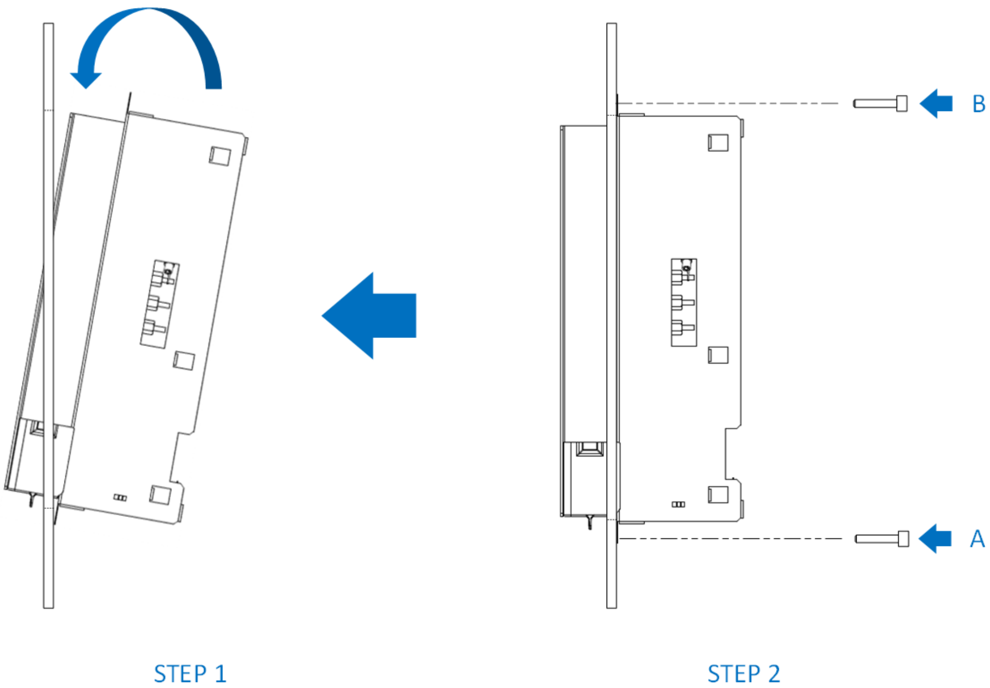


Figure 4-18: : Mechanical Mounting of a Drive Recessed Mount

4.4.4 Mounting a Capacitor Module

The following sections show the capacitor module mounting holes for the Duct mount (*Figure 4-19*), Wall mount (*Figure 4-20*) and Recessed mount (*Figure 4-19*) variants.

The installation is intended to insert the bottom screw first, before the capacitor module is lifted into position. The screw should not be made tight, but screwed with about 5mm of thread exposed. Lift the capacitor module onto the screw so the screw supports the weight of the capacitor module in the bottom slot in the chassis then tilt it back into position and install the top mounting screw and tighten both screws to a torque of 3.0 Nm. Refer to *Figure 4-19* and *Figure 4-20*

The Capacitor Modules must be mounted furthest away from the PIU, after all Drives.

Uninstalling the product is the reverse of the installation procedure. Ensure mains power has been isolated from the PIU. Refer to *5.3.1 Power Isolation*

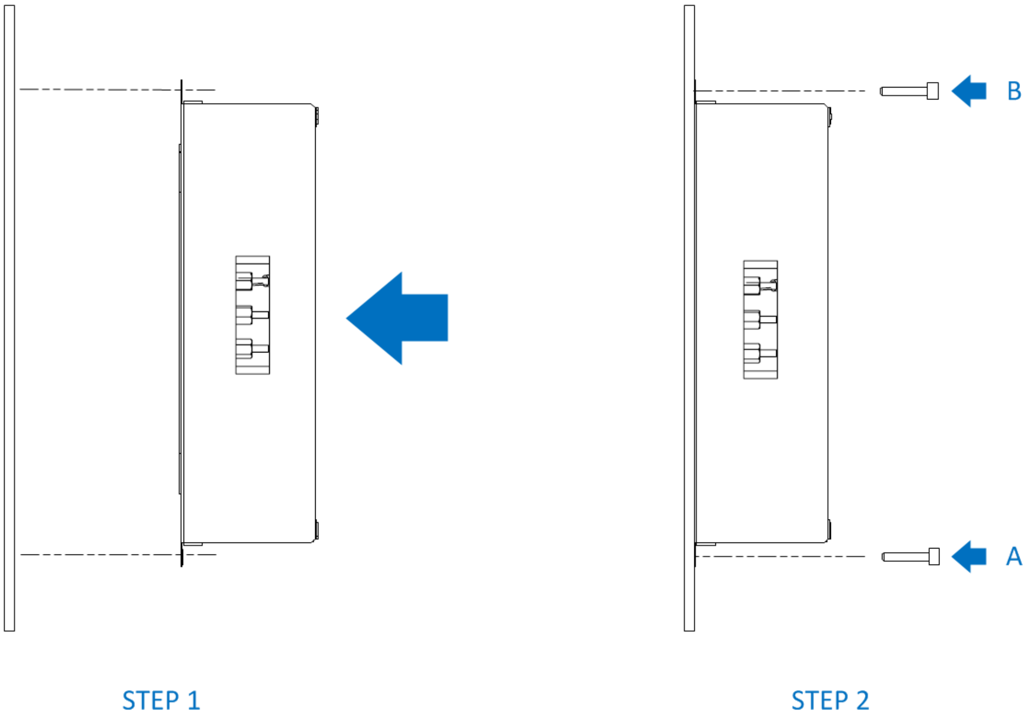


Figure 4-19: Mechanical Mounting of Capacitor Module for a Duct and Recessed Mount

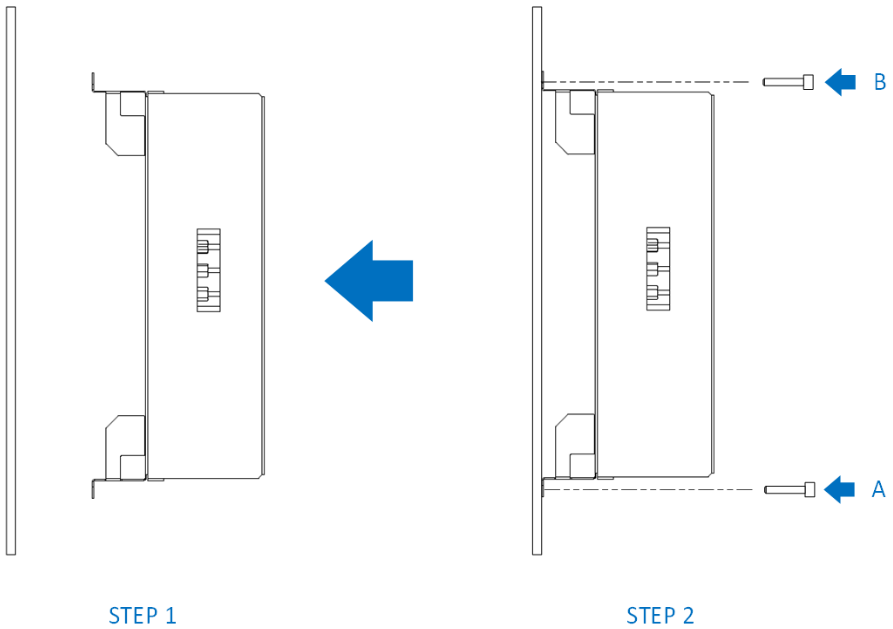


Figure 4-20: Mechanical Mounting of Capacitor Module for a Wall Mount

4.4.5 System Installation

The AMD5x PIU and Drives must be installed as a system with the following steps.

4.4.5.1 Protective Cover Installation

Fit the Protective Cover to the last Drive or Capacitor Module on the right to prevent accidental contact with the Busbars as shown in *Figure 4-21* and *Figure 4-22*, *Figure 4-23*. Note, if there is no room in the electrical cabinet to fit and access this Cover, it must be fitted before mounting the Drive or Capacitor Module to the gear tray. The Protective Cover and the two mounting screws are included with the PIU for the system.

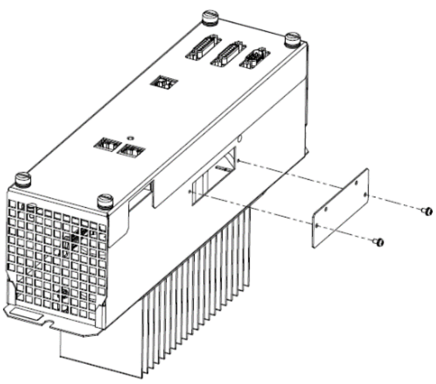


Figure 4-21: Fit the Protective Cover to the last Drive in the Array – Duct Mount

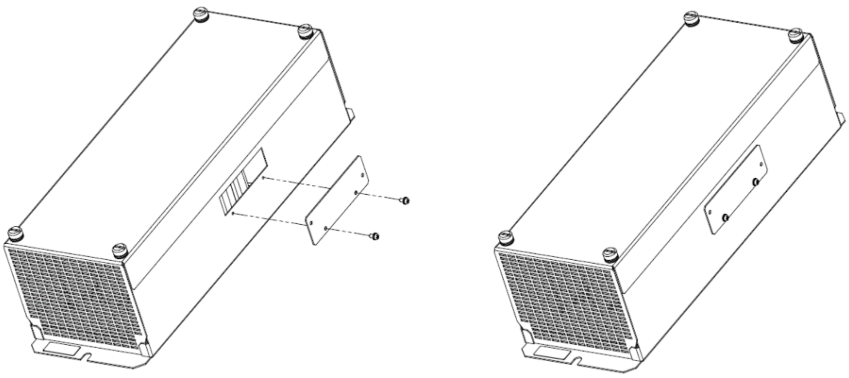


Figure 4-22: Fit the Protective Cover to the last Capacitor Module in the Array – Duct or Recessed Mount

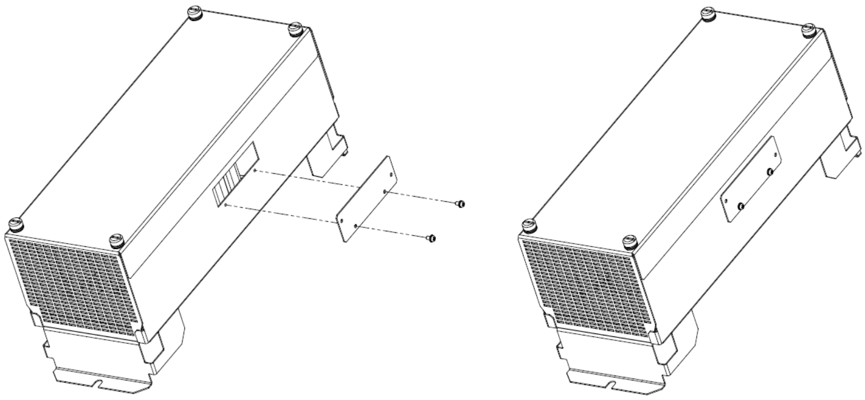


Figure 4-23: Fit the Protective Cover to the last Capacitor Module in the Array - Wall Mount

4.4.5.2 DC Busbar and PE Wire Harness Mounting

There are three standoffs for each module that require the high voltage and PE busbars to be fitted. The busbars when fitted to the standoffs will interlock between each unit to provide the common interconnected DC bus for the drive array.

NOTE: The open ends (forked end) of the Busbars must point to the LEFT (towards the PIU). See *Figure 4-24*

Each unit's chassis contains a PE wire harness to be connected to the DC bus system. Ensure that the terminal for the PE wire harness is connected to the busbars.

Tighten all M4 nuts for each busbar standoff to a torque of 1.5 Nm.

Refer to *Figure 4-22* for fitment of the Protective Cover to the Capacitor Module in the array

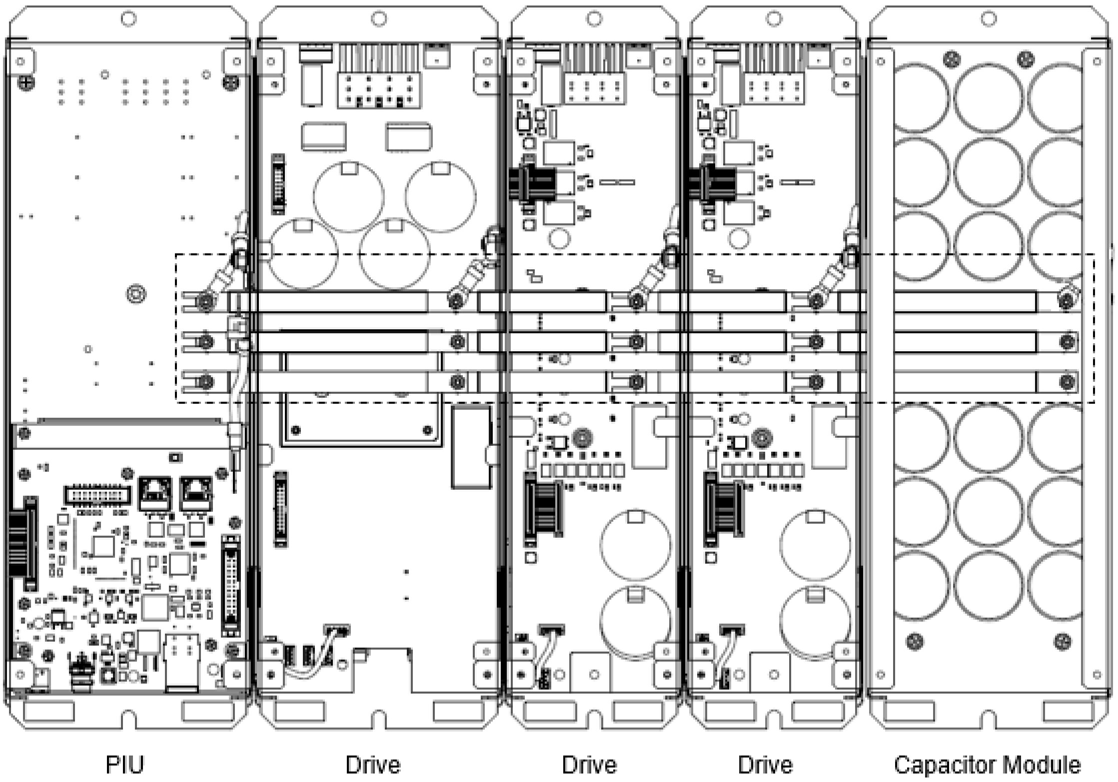


Figure 4-24: Fitted high voltage DC Busbars and PE Wire Harnesses

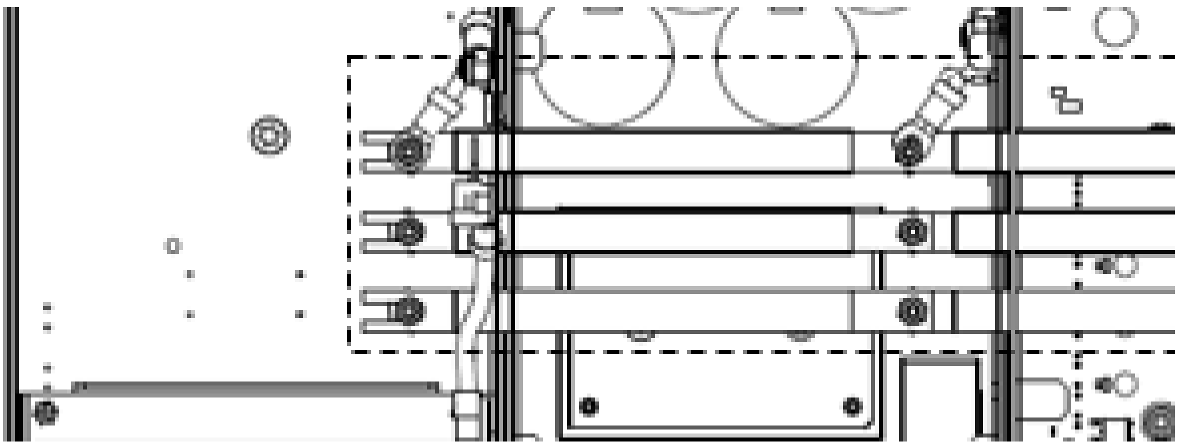


Figure 4-24-A: Close-up view of DC Busbars pointing to the LEFT

4.4.5.3 Fit Drive Controller PCBAs

Prior to fitting the controller cards to the drives, connect the two ribbon cables for each drive to the controller PCBA as shown in *Figure 4-25*.

For 35A drives, feed the ribbon cables through the rectangular cutouts in the tray.

For the 20A, 12A, 6A and 3A drives, route the ribbon cables between the LHS of the tray and the chassis wall.

Carefully place the Controller PCBA tray into each drive as shown and tighten the four captive screws on each tray.

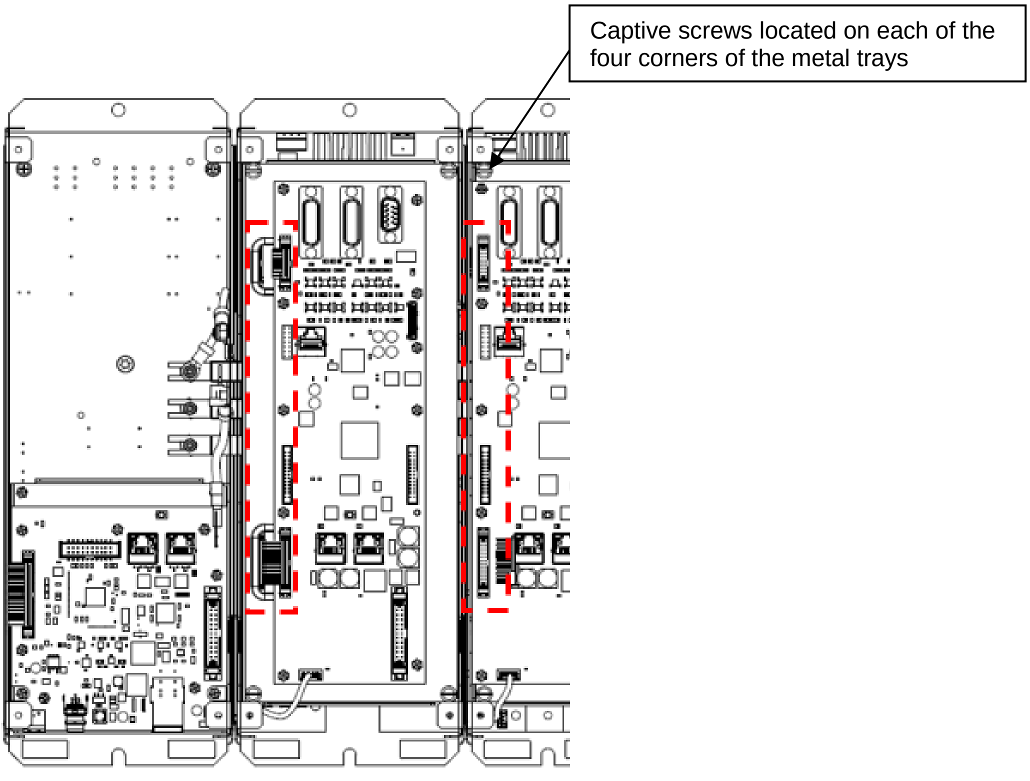


Figure 4-25: Fitted Drive Controller PCBA

For Wall and Recessed mount drives, connect the loose plug end into the controller PCBA connector as shown in *Figure 4-26.*

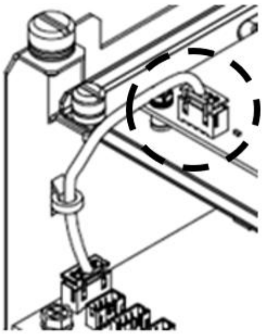


Figure 4-26: Connection of the harness plug to the Drive controller PCBA

4.4.5.4 Fit 24 Vdc Ribbon Cable

Fit the 24 Vdc Ribbon Cable as shown in *Figure 4-27*, ensuring that the end marked “POWER SUPPLY THIS END” is fitted to the PIU. Connect the ribbon cable from left to right across the Drive array ensuring the excess ribbon cable is folded into each drive. For examples of folded ribbon cable assemblies see section *11.4 24 Vdc Ribbon Cable.* The ribbon cable does not extend into any Capacitor Modules.

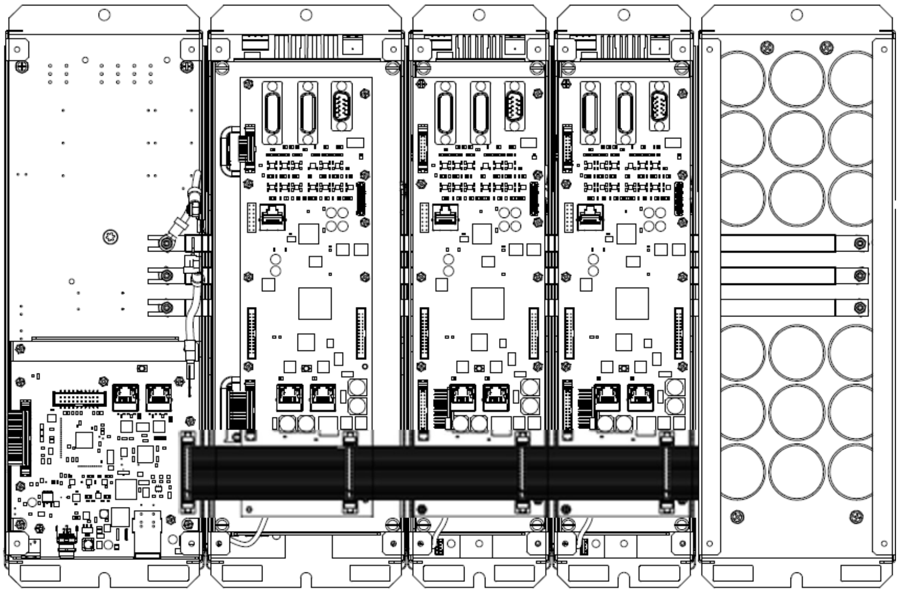


Figure 4-27: Connection of the 24Vdc Ribbon Cable to the PIU and Drive controller PCBAs

4.4.5.5 Fit Front Covers to the PIU and Drives

Fit the Front Covers to the PIU, Drives and Capacitor Module by tightening the four captive screws as shown in *Figure 4-28*. Ensure the cover flanges are located within the folded tabs on the chassis as shown in *Figure 4-29*.

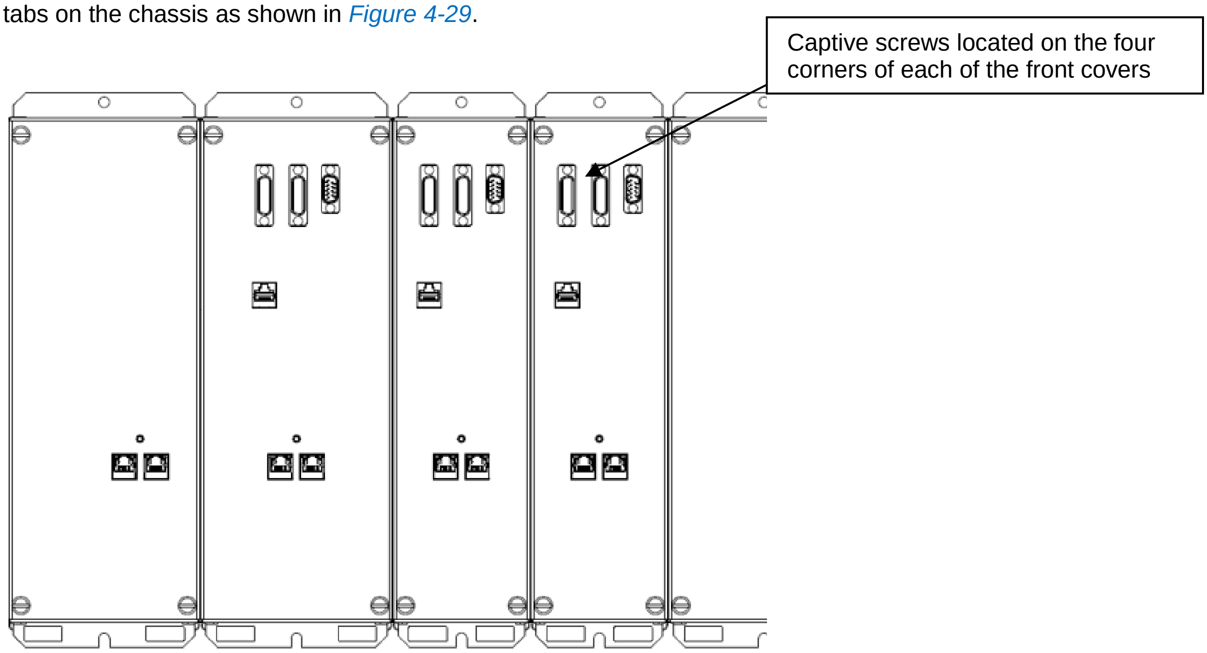


Figure 4-28: FItted Front Covers on PIU, Drives and Capacitor Module

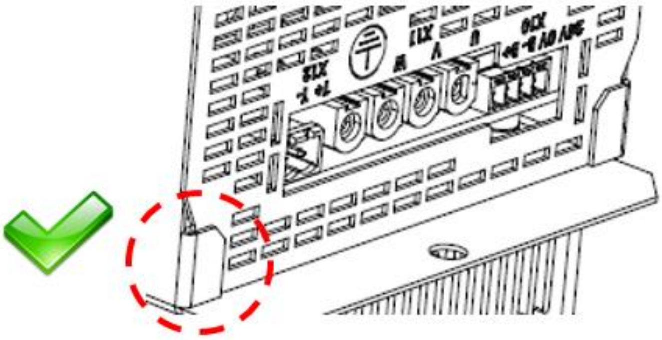


Figure 4-29: Correct fitment of the cover flanges within the chassis tabs

Connect the electrical plugs to complete the installation as per sections *3.6 PIU Connector Overview* and *3.7 Drive Connector Overview.*

4.4.6 Uninstalling the PIU and Drive System

Ensure mains power has been isolated from the drives. Refer to *5.3.1 Power Isolation.* The removal of the entire PIU and Drive system is the reverse order of section *4.4.5 System Installation.*

4.4.7 Uninstalling the PIU or one Drive from the Array

The following steps are required when removing a PIU or Drive from an AMD5x Drive System. Ensure mains power has been isolated from the drives. Refer to *5.3.1 Power Isolation.*

DANGER HIGH VOLTAGE - The Main Isolator feeding the PIU must be switched to the **Off** position at least 15 minutes before any work is commenced on the unit. The operator must check the DC Bus is discharged and isolated from mains supply with a tested working voltage measuring instrument prior to disconnecting any connectors or exposing any part of the DC Bus.

Refer also to figures in *4.4.5 System Installation*.

- Unplug and remove all connectors to the PIU/Drive, and also to the adjacent PIU or Drives modules.
- Remove the front cover from the PIU/Drive by undoing the four captive fasteners on the cover. Also remove the front covers of the adjacent PIU or Drives modules.
- Unplug and remove the 24 Vdc Ribbon Cable (Refer to *11.4 24 Vdc Ribbon Cable*) at the bottom right of the controller PCBA. The ribbon cable should also be unplugged on adjacent drives to allow sufficient loose ribbon cable for the PIU/Drive to be removed.
- Unplug the two ribbon cables at the left of the controller PCBA. The two ribbon cables connect the controller PCBA to the bottom inverter PCBA.
- Remove the three exposed Drive controller PCBAs by undoing the four captive fasteners on each metal tray. Note the PIU controller PCBA is not required to be removed.
- Remove the M4 nuts holding the Busbars in the three Drives (or PIU plus two Drives) and remove the Busbars. Ensure that the nuts and Busbars are not dropped in the process.
- Follow steps 1 through to 2 as per *4.4.2 Mounting a PIU*, *4.4.3 Mounting a Drive* and *4.4.4 Mounting a Capacitor Module* in reverse order to uninstall the PIU/Drive module.

4.5 Fan Housing Assembly Replacement

The following steps are required when removing a fan housing assembly from a Wall or Recessed mount PIU or Drive. Please refer to *11.10 Fan Replacement Kit for Wall and Recessed Mount* for appropriate fan replacement kit. Ensure the drive system is powered down and mains power has been isolated from the drives. Refer to *5.3.1 Power Isolation.*

DANGER HIGH VOLTAGE - The Main Isolator feeding the PIU must be switched to the **Off** position at least 15 minutes before any work is commenced on the unit. The operator must check the DC Bus is discharged and isolated from mains supply with a tested working voltage measuring instrument prior to disconnecting any connectors or exposing any part of the DC Bus.

Only Qualified Electrician / Service Personnel should perform the following Procedure. Make sure that your work area is safe and clean. Make sure that no foreign objects are dropped into the unit(s) while performing this procedure.

For Wall Mount units, the fan housing assembly can be replaced without removing it from the gear tray. It is only required to remove the lower mounting screw see *Figure 4-30* below.

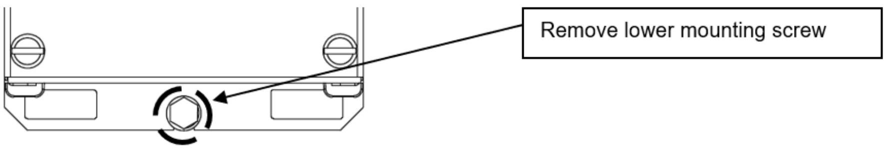


Figure 4-30: Remove lower mounting screw for Wall mount variants only

For Recessed Mount units remove as per *4.4.7 Uninstalling the PIU or one Drive from the Array.*

4.5.1 Removing the Faulty Fan Housing Assembly

For the PIU as shown in *Figure 4-31*, carefully cut and remove the cable tie that holds the fan harness to the side wall, disconnect and remove the plug so that the harness is loose.
For the PIU there is only one fan connection.

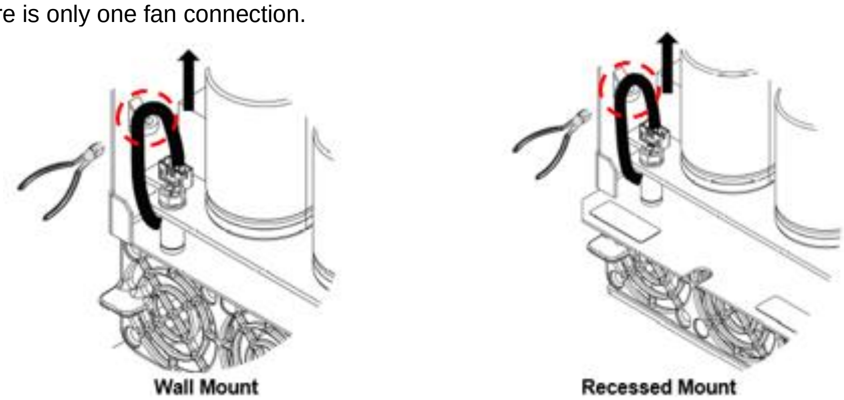


Figure 4-31: Disconnect and remove the fan plug from the PIU PCBA

For the Drives, carefully disconnect and remove the fan plug(s) from the board connector(s) as shown in *Figure 4-32.*

For the 35A and 35AH Drives there are three fan connections.
For the 20A Drive there are two fan connections.
For the 12A / 6A / 3A Drives there is one fan connection.

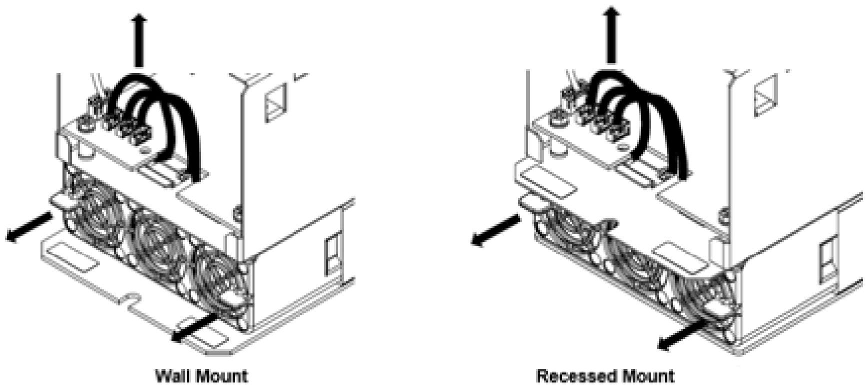


Figure 4-32: Disconnect and remove the fan plug(s) from the Drive PCBA

Pull on the handles as shown in *Figure 4-32* to disengage the fan housing assembly from the unit. Carefully remove the fan housing assembly completely and then the whole fan housing assembly can be discarded.

For Recessed mount variants, an easy method to remove the fan housing assembly is to do the following:

- Place index fingers in the fan housing recess located on the sides and pull back while using thumbs to push against the chassis return tabs as shown *Figure 4-33.*
- The plastic snaps will disengage from the chassis and the housing assembly can be removed.

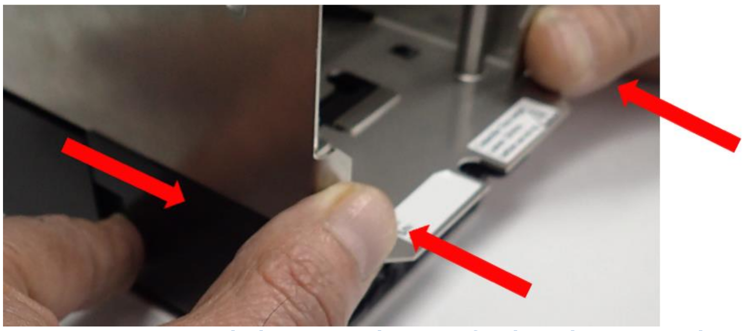


Figure 4-33: Recommended Recessed mount fan housing removal method

4.5.2 Installing the New Fan Housing Assembly

Route the fan harness(es) underneath the metal chassis and into the unit. Each fan connector will enter the unit through its own slot in the chassis.

Carefully slide the fan housing assembly into the unit as shown in *Figure 4-34* while also pulling the fan wires up through the slot in the chassis. Ensure the fan wires are not damaged during this process. Once the fan housing assembly has been fully inserted, check the plastic snaps are located into their slots in the chassis.

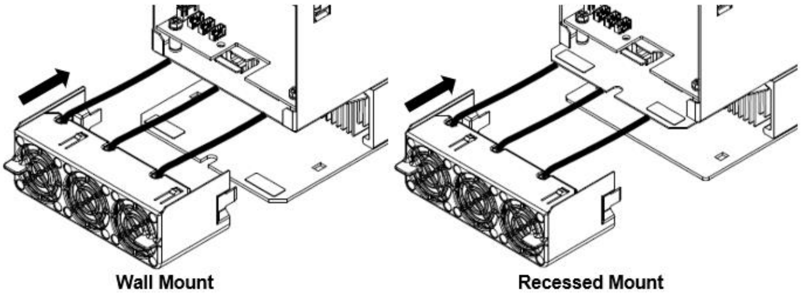


Figure 4-34: Routing the fan wires through the chassis slot into the Drive

4.5.3 Fan Harness Routing and Connection

For the PIU, route the fan harness as shown in *Figure 4-35* through the cut-out hole in the PCB board.

Before fixing the wire harness to the chassis wall with a new cable tie from the box, ensure the plug is fully inserted and plugged into the connector on the PCB board and there is no strain on the harness.

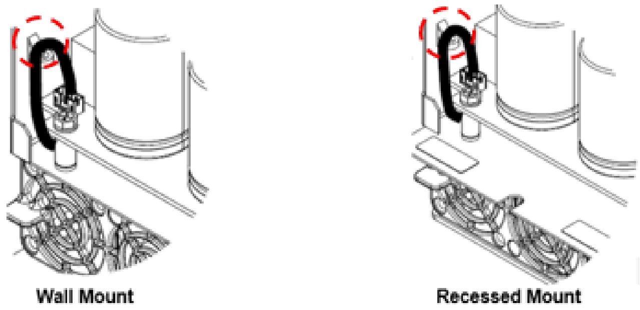


Figure 4-35: Connecting the fan wire plug into the PIU PCBA

For the Drives, route the harness(es) through the cut-out hole in the PCB board as shown in *Figure 4-36*. Insert the plug(s) into the correct connector on the PCB board. (For multiple fans the LHS harness to connect to the LHS connector on the PCB board etc..)

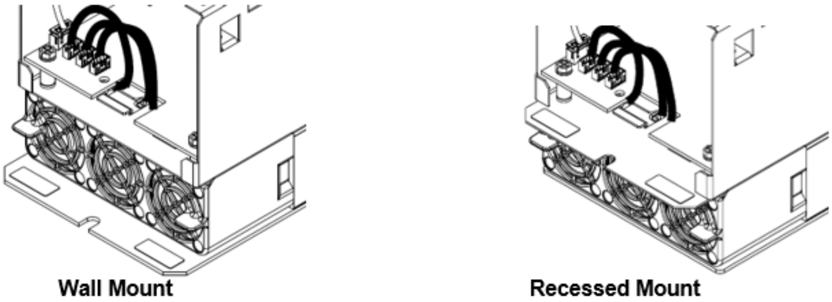


Figure 4-36: Connecting the fan plug(s) into the Drive PCBA

For Recessed mount PIU and Drives, follow the instructions in *4.4.7 Uninstalling the PIU or one Drive from the Array* in reverse order to reinstall the Unit back.

Ensure all fitments and connections have been completed.

Perform the necessary fan start up test procedure to verify fan and module function in section *6.3.1 Fan Operation on Wall and Recessed Mount Drives*.

5 Power Wiring

5.1 What This Chapter Contains

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

- Mains power supply and protective earthing
- EMC compliance
- Regenerative Brake Resistor Selection
- Drive and motor connection

5.2 Mains Power Supply

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

- Isolation switch to allow correct isolation of the system from the power supply
- Circuit breakers or fuses to protect cables, filter and drive
- EMI filter to limit electrical noise on the mains supply
- Line reactor to allow proper function of the PIU, and to limit conducted harmonics on the mains supply.
- Contactor(s) for safety under E-Stop conditions.

The EMI filter and line reactor are also required for EMC compliance; refer to *5.5 Installations Conforming to the EMC Directive* for details on the recommended EMC compliant installation.

The AMD5x PIUs and Drives are suitable for use on supplies of installation overvoltage Category III, according to IEC 61800-5-1. This means they may be connected permanently to the supply at its origin in a building, but for machine installations closer to primary distribution supply (overhead cables etc.) additional over-voltage suppression (transient voltage surge suppression) must be provided to reduce Category IV to Category III.

5.2.1 3 Phase AC Voltage Supply

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

The AMD5x PIU has mains detection circuitry and errors will be generated if the PIU is operated outside specifications, or in the event of loss of one or more phases of the mains supply. The PIU cannot be operated with a single phase supply. The mains supply to the PIU can be connected in either phase rotation.

5.2.2 Connection of PIU to Grounded Systems (TN or TT)

The AMD5x PIU is designed to operate with grounded TN & TT systems where the three phase supply is from a transformer with a grounded star point (Refer to *Figure 5-1*). With TN & TT systems any drive, motor or wiring ground fault generates substantial currents which must be quickly interrupted with circuit breakers in the mains supply as specified in *5.3 Power Disconnect and Protection Devices.*

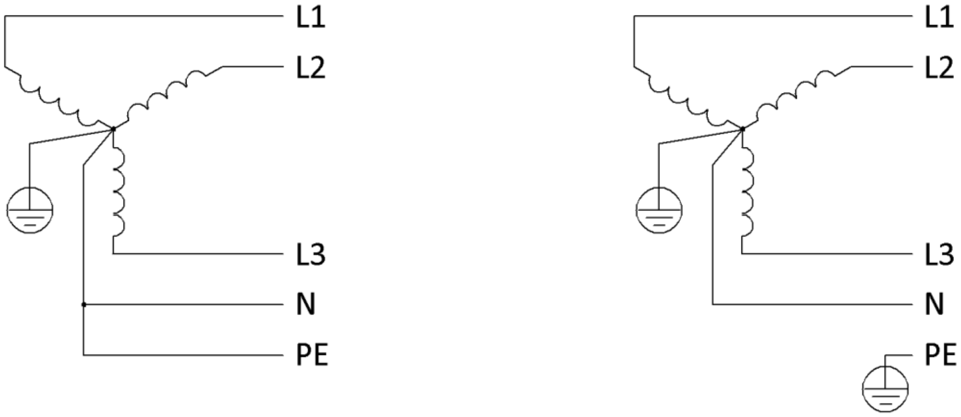


Figure 5-1: TT mains supply and TN mains supply connections.

5.2.3 Connection of PIU to non-grounded (IT) or Delta systems

Warning: The AMD5x PIU must not be connected to a non-grounded IT or Delta system as this will exceed PIU Drive electrical safety limits. Proper function of the PIU is reliant upon an input supply that is ground referenced.

The incorrect use of transformer connection systems with asymmetrical grounding such as “Corner Earth”, “High-Leg” & “Scott-T” (shown in *Figure 5-2*) will generate a a warning **W_Gnd**=1 (see *Table 37*)) and the PIU will not start. If the **W_Gnd**=1 bit is set during drive operation, the PIU will continue to operate, and the drives must be stopped by the external CNC via EtherCAT interface, before the PIU is disabled to prevent PIU damage. The **W_Gnd**=1 bit may also be caused by drive or motor phase to earth faults.

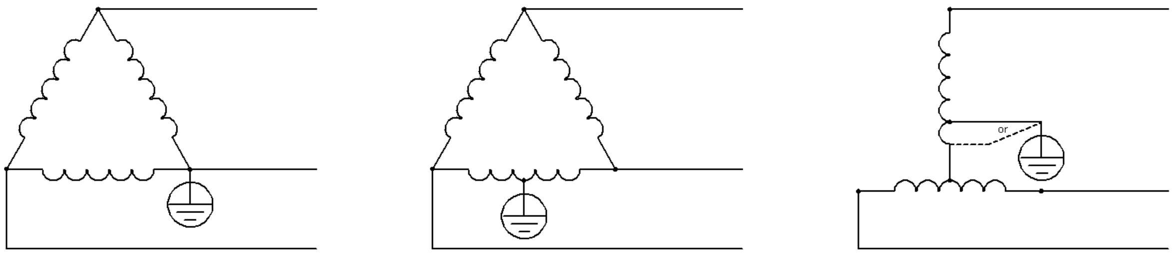


Figure 5-2: Incompatible Corner Earth, High-Leg & Scott-T mains supply connections.

For asymmetrically earthed or non-earthed IT systems mains an isolating transformer must be used with secondary output connected to TN or TT systems.

5.2.4 Residual Current Detection (RCD) protection

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

- It is only permissible to use selective AC/DC-sensitive residual-current circuit-breakers, Type B.
- Parts of the electrical equipment and machine that can be touched must be integrated in a protective grounding system.
- If an external EMI filter is used, a delay of at least 50ms should be incorporated to ensure spurious trips are not seen.
- The leakage current is likely to exceed the trip level if all 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: The AMD5x system is designed for category C3, and is not intended to be used on a low-voltage public network which supplies domestic premises.

Warning: Earth leakage current in the protective earthing conductor exceeds 3.5 mA AC for the AMD5x system.

5.3 Power Disconnect and Protection Devices

A manually-operated mains supply disconnecting device (the “Isolator”) must be installed between the AC power source and the PIU. 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 AMD5x PIU must have suitable input power protection for the three phase input. This protection 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.

Table 23: Recommended AC Input Switchgear and Input Mains supply wire sizes

PIU Power rating	3Φ AC supply	Rated Continuous Input Current (rms)	Isolator Thermal Rating	Circuit breaker (C-type)	Contactor AC3* Rating	Minimum wire size	
						AWG	mm2
15kW	380-480V L-L	26A	32A	32A	32A	11	4
24kW	380-480V L-L	35A	40A	40A	40A	10	6

*A Contactor AC3 Rating is a switching rating, and this is lower than its AC1 Thermal Rating.

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

- The Input Mains supply wire size should be used for the following power connections:
  - 3 Phase AC connection from Isolator to Circuit Breaker.
  - 3 Phase AC connection from Circuit Breaker to Contactor(s).
  - 3 Phase AC connection from Contactor(s) to EMI Filter.
  - 3 Phase AC connection from EMI Filter to Line Reactor.
  - 3 Phase AC connection from Line Reactor to PIU.
- Wire sizes in *Table 23* are a guidance only as installation methods such as grouping, length, use of conduits and ambient temperature may affect current capacity.
- Where more than one wire per connector terminal is used, the combined diameters should not exceed the connector or terminal maximum wire capacity.
- The connectors for X1, X2 & X11 are suitable for both solid and stranded wires.
- Circuit Breakers must be thermal magnetic type and have genuine C-curve. Genuine C-curve Circuit Breakers are essential to allow the AMD5x PIU to deliver the published overload capability. See *10.4.1 AMD5x PIUs* for AMD5x PIU overload capability.

5.3.1 Power Isolation

Power isolation is required to prevent risk of electric shock during maintenance and assembly operations. Ensure isolation switches, isolation circuit breakers and contactors meet the requirements and applicable safety regulations of the region of operation. Turn the Main Disconnect mains isolator switch to the Off position and follow the appropriate lockout procedure when installing or maintaining the drive. See Isolator Ratings given in *Table 23.*

DANGER HIGH VOLTAGE - The working DC Bus is live at all times when power is on. The Main Isolator feeding the PIU must be switched to the **Off** position at least 15 minutes before any work is commenced on the unit. The operator must check the DC Bus is discharged and isolated from mains supply with a tested working voltage measuring instrument prior to disconnecting any connectors or exposing any part of the DC Bus.

5.3.2 Mains Contactors

When the AMD5x Passive Infeed Unit (PIU) is connected directly to a 3 phase mains AC supply with no isolation contactors, the Drive Array DC Bus & Servo Drive motor armature cable outputs are constantly at a high voltage even when the PIU is not enabled. The PIU does not include a method to isolate the AC mains supply. Customers should conduct a risk assessment according to the Safety of Machinery Directive or other relevant standard to determine if contactor(s) are required, and how they should be coupled with EMERGENCY OFF functions to provide electrical isolation of output power.

It is recommended that at least one isolation contactor be used on the three phase AC mains supply to the Passive Infeed Unit. The contactor(s) can provide a safe and reliable method of isolating the Drive Array DC Bus & Servo Drive motor armature cable outputs, from the line supply. See Contactor Ratings given in *Table 23.*

5.4 Grounding

Earth and ground are synonymous; where earth is used in Europe, Australia and New Zealand and ground is used in the US and Canada. 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. The shield on motor cables reduces emissions from the drive, and correct shield grounding prevents electrical noise interference to control circuits.

The Protective Earth (PE) Connection from the mains supply eliminates shock hazards by connecting the AMD5x PIU and Drive, and cabinet parts at same earth potential. The PE also conducts fault currents to ground until the safety device (fuse or circuit breakers) disconnects the drive from the mains.

Symbol for Protective Earth (PE)

The mains supply protective (PE) wire must have a cross sectional area equal to $10mm^2$ (copper conductors), or a second earthing conductor of the same cross-sectional area as the original earthing conductor must be added. The correct mains supply protective (PE) wire size must be used to minimise PIU and Drive touch current.

On the PIU, the mains supply PE is connected to X2 plug and the location is also identified by the PE symbol on the sheet metal.

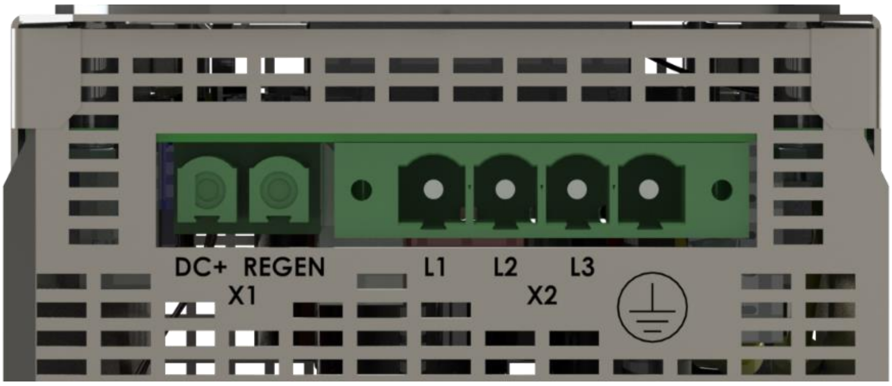


Figure 5-3: PIU mains supply connection X2 with PE symbol on the sheet metal

On the Drive, the motor PE is connected to X11 plug and the location is also identified by the PE symbol on the sheet metal.

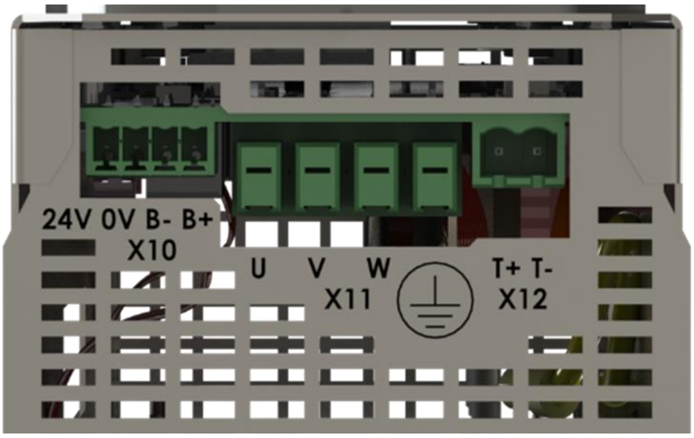
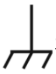


Figure 5-4: Drive motor connection X11 with PE symbol on the sheet metal

In multiple drive installations, each motor must be individually wired to its corresponding X11 plug PE point. Do not daisy chain PE connections from one Drive to the next or to a separate earth bar. The AMD5x system uses an internal PE Busbar which is connected to the customer supply with PIU (X2) and then distributed to all drives. Refer *5.10 DC Busbar and PE Terminals*

The AMD5x PIU and Drives are designed to be installed on a metal gear tray 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

It is recommend the metal gear tray be made of zinc plated mild steel which provides reliable low impedance ground connections to all mounted equipment. Painted panels should not be used as it is difficult to properly remove the paint and obtain a reliable Earth connection. Paint removal also allows corrosion of the unprotected mild steel and can affect the Earth connection. In addition, the RF grounding performance of a plated panel far exceeds that of a painted un-plated panel (even if paint is removed locally).

5.5 Installations Conforming to the EMC Directive

EMC stands for Electromagnetic compatibility. It is the ability of electrical/electronic equipment to operate without problems within an electromagnetic environment. The equipment must not disturb or interfere with any other product or system within its locality. Variable speed drives are a source of interference, and all parts which are in electrical or airborne connection within the power drive system (PDS) are part of the EMC compliance defined by EN 61800-3:2004. *See 10.8.2.1 European EMC Directive EN 61800-3*

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 5-5: Common Mode Noise Current Paths in a Drive* System. The common mode currents return to the drive inverter by the lowest available impedance paths which must be carefully managed to prevent interference voltages being generated in other equipment connected to the same earth system. The internal common mode capacitors of the drive provide one return path (I_{DC}) to the drive, and the EMI line filter provides another return path I_{LF} via the drive mains input.

It is important that the level of interference fed back to the mains supply via path I_{PE} is minimised because all other equipment in the installation is also connected to this same mains supply and could therefore be affected by this interference. Adding an EMI filter provides a low impedance path for interference currents from the earth plane back to the PDS via path I_{LF} and will reduce mains supply interference currents I_{PE}.

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 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 the customer in accordance to the appropriate standards for their application and market.

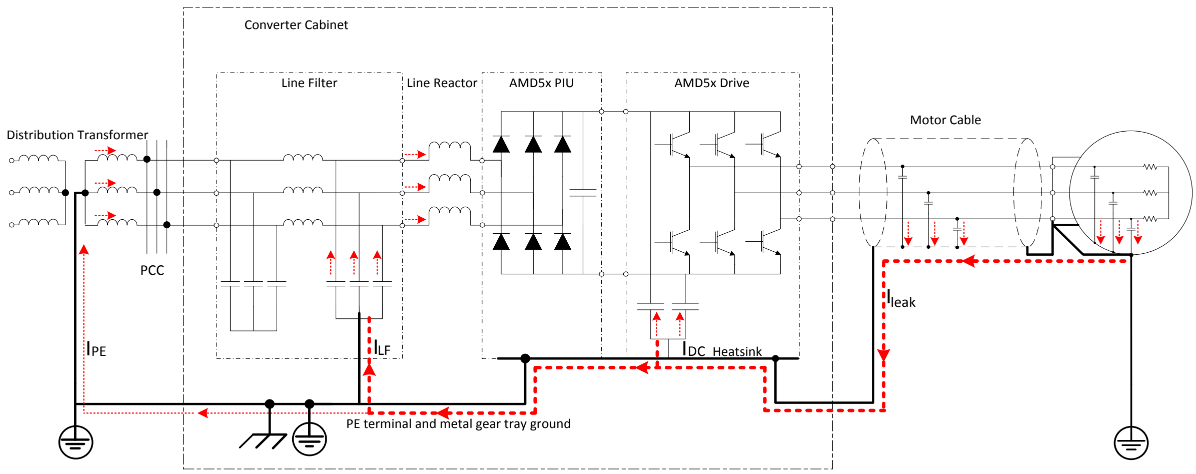


Figure 5-5: Common Mode Noise Current Paths in a Drive System

5.5.1 Harmonics and Reactive Power Compensated Supplies

The PIU input diode bridge is a non-linear load to the mains supply and generates low frequency conducted harmonic effects in the frequency range up to 9 kHz. 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 exact harmonics and voltage distortion is site specific, but the harmonics can be reduced to acceptable levels defined by EN 61000-3-12 with the addition of an Line Reactor (inductor) as specified by *Table 24: Recommended EMC components for a 380-480V L-L 3 Phase supply. See also 10.8.2.3 European Low Voltage Directive EN 61000-3-12*

Warning! A Line Reactor is required to allow proper function of the PIU, and to limit conducted harmonics on the mains supply. Under no circumstances attempt to operate the PIU without a line reactor fitted.

In mains supply installations equipped with reactive power compensation capacitors, the harmonic currents drawn by the PIU may cause resonances excited by the harmonic currents being drawn. Therefore, it is strongly recommended that any power compensation capacitor equipment be fitted with suitable reactor protection and damping to prevent harmonic resonances.

5.5.2 3 Phase Supply System Wiring

Figure 5-6 shows the recommended EMC components for wiring of a 3 phase supply system. An EMI filter and a 3 phase line reactor (inductor) are installed on the input power side.

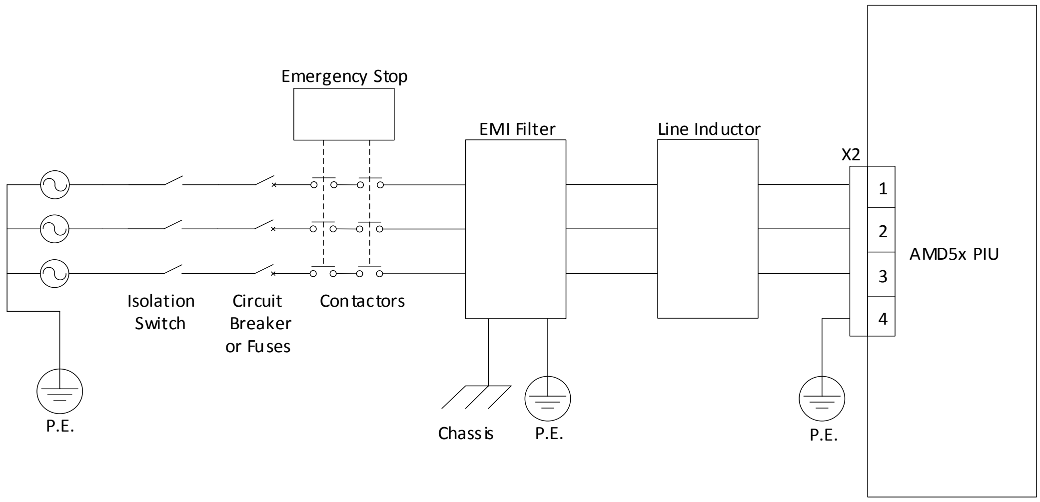


Figure 5-6: EMC components installation for a 3 phase supply

Table 24: Recommended EMC components for a 380-480V L-L 3 Phase supply		
PIU Power Rating	**3 Phase EMI Filter**	**Line Reactor**
15kW	Schaffner FN3258-30-33 (30A) or FN258-30-33 (30A)	Schaffner RWK 3044-30-92 (1mH 30A) or MTE RLW-002805 (1.3mH 28A) or TDK B86305L0030R000 (1mH 30A) or BLOCK LR3 40-4/30 (1mH 30A)
24kW	Schaffner FN3258-42-33 (42A) or FN258-42-33 (42A)	Schaffner RWK 3044-48-92 (0.61mH 48A) or MTE RLW-004603 (0.55mH 46A) or TDK B86305L0046R000 (0.64mH 46A) or BLOCK LR3 40-4/45 (0.65mH 45A)

5.5.3 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 EMI filter input) to "noisy" power cables by careful routing and cable segregation.
- It is preferable to mount EMC components on a 3mm thick (or greater) bare galvanised steel, zinc-plated or aluminium panel to provide a low impedance return path.
- 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 *5.4 Grounding*).
- Minimize motor cable length, and use correctly shielded motor cables (refer to *5.6.4 Motor Power Cable Shielding*). For longer cable lengths a ferrite ring on the drive output will reduce EMC noise.
- Ensure that the EMI filter is always used with a line inductor that reduces rms currents, otherwise these may lead to currents exceeding the EMI filter rating.
- Ensure the EMI filter is connected to the mains supply for maximum performance (refer to *Figure 5-6)*
- Ensure the current rating of EMC components is coordinated with the mains power disconnect and protection devices. Following the recommendations in Table 23 and Table 24 will ensure this coordination.

5.6 Motor Connections

The servo motor phase wires (U, V, W) must be correctly connected to the Drive output (X11) to ensure the servo motor operates properly. See *Figure 5-7*

Do not connect 3 phase AC mains power supply to the Drive (U, V, W) terminals, otherwise damage may occur to the Drive.

The motor PE ⏚ must be connected to the Drive connector PE terminal (X11). Do not connect directly to the mains supply protective earth as this will increase EMC noise.

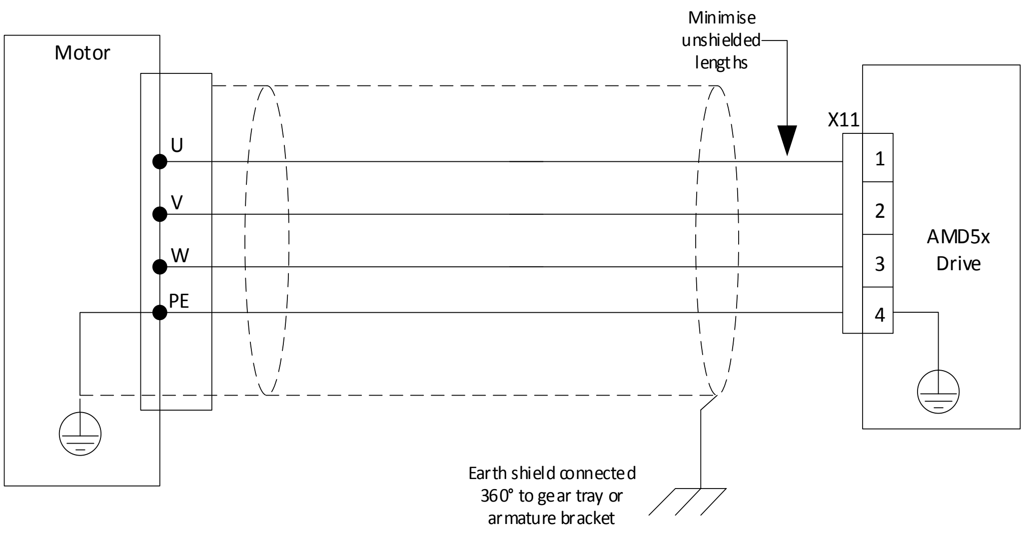


Figure 5-7: Motor connections and shielding

5.6.1 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 may form part of a safety system.

If a contactor is employed in this way, it is essential that measures be taken to ensure that the contactor is not commanded to open or close whilst the Drive is enabled. One way to achieve this is to employ the same PLC that enables the Drive to be in control of the contactor via a control relay.

Ensure that shielding of the motor cable is continued on both sides of the motor circuit contactor.

5.6.2 Shielded Armature Cable Schematic

Shielded armature cable schematic for Beta and Gamma Motors is shown in *Figure 5-8* with connector pin identification. K5B-ASMD cable variant catalogue numbers can be found in *11.8.2 Shielded Armature Cable for Beta/Gamma Motors*.

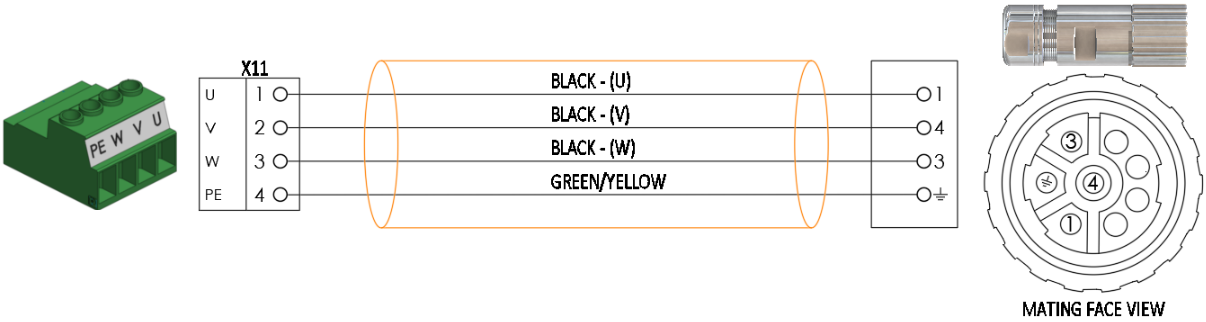


Figure 5-8: K5B-ASMD schematic and connector pin identification

5.6.3 Shielded Armature Cable with Thermal Sensor for LinX Motor Schematic

Shielded armature cable with thermal sensor schematic for LinX Motors is shown in *Figure 5-9* with connector pin identification. K5B-T1MD cable variant catalogue numbers can be found in *11.8.8 Shielded Armature Cables for LinX M motor with Temperature*.

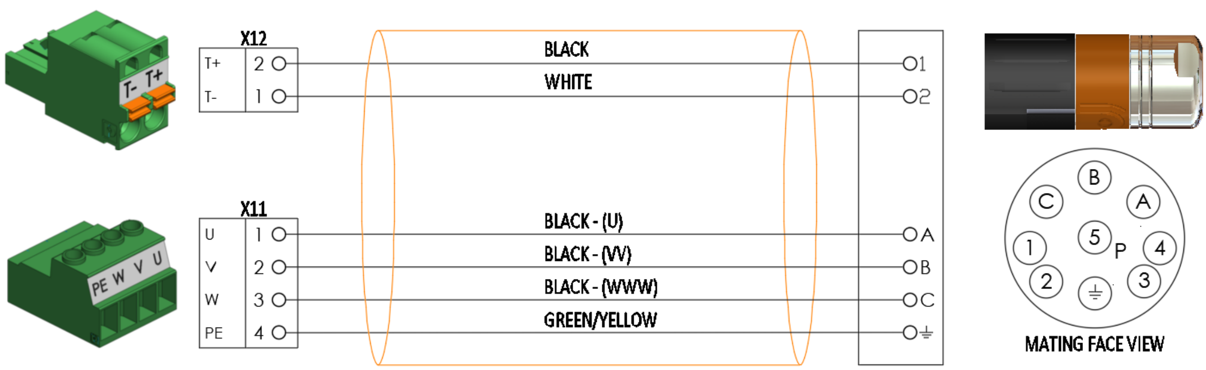


Figure 5-9: K5M-T1MD schematic and connector pin identification

5.6.4 Motor Power Cable Shielding

Motor power cables from the AMD5x drive to the motor must have braided outer shields to minimize effects to other equipment. The cable shield minimizes radiated 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 correct shield grounding. *Figure 5-5: Common Mode Noise Current Paths in a Drive* System illustrates the path of common mode noise currents. The following guidelines must be followed.

- Power cables between the Drive and motor must be shielded, and the shield grounded at both ends.
- There must be no break in the shield between the motor and Drive
- Use motor cables with high conductivity shields (low transfer impedance), and with shields that cover at least 80% of the cable.
- Use motor cables with dedicated PE conductor(s). Do not use the shield as a PE.

5.6.5 Power Cable Shield Clamping

The motor power cable shield returns common mode noise currents back to the Drive and the shield must be correctly clamped to the metal gear tray as close as possible to the Drives. Failure to correctly clamp the shields may result in the common mode noise currents finding alternative paths which may affect other electrical equipment. The gear tray layout and correct equipotential bonding of the shield in the cabinet is a critical component in managing EMC problems. The following guidelines must be followed:

- It is preferable to use motor connectors where the shield is terminated to the connector housing, and thus is directly bonded to the motor. If a shield terminated motor connector is not used, then the cable shield must clamped to the earthing system close to the motor.
- Select shield clamps with low impedance in the MHz range, and those which enclose the cable shield, such as in *11.8.9 Motor Power Cable Shield Clamps*.
- Shield clamps may include integral (additional) mechanical strain relief.
- Local strain relief for the motor power cable must be provided to support the connection of the shield clamp.
- Shield clamps must be connected to the exposed metal braid of the cable. For armature cables such as in *11.8 Cables,* clamp to existing exposed metal braid at Drive cable end. For customer supplied armature cables, remove a sufficient amount of outer sheath close to Drive cable end. See example in *Figure 5-10.* Ensure that the metal braid is not damaged in this process.
- Shield clamps can be mounted directly to the gear tray, or on to a common DIN rail, or on to a common Bus Bar.
- If using painted metal gear tray, remove any paint to expose the bare metal beneath the shield clamp, or DIN rail, or Bus Bar.
- Do not connect shields to cabinet entry points. Only connect to the Drive gear tray as close as possible to the Drives.
- Do not terminate shield screens with pigtails, or PE conductors.

Figure 5-10: Example Shield clamp mounting for gear tray

5.6.6 Motor Signal Cable Shielding

The motor encoder signal cable must use drive and motor connectors where the shield is terminated to the connector housing. The encoder signal cable should not use a shield clamp.

5.6.7 Earth Bond Strap

Any installation which mounts the AMD5x system on a painted gear tray should use braided earth bond straps from each Drive and PIU metal chassis to the gear tray or nearby common shield clamp DIN rail / Bus Bar. If the earth bond strap is connected to the gear tray, then paint must be removed under the whole connection point. A short, wide braided strap provides low impedance for common mode noise currents, and cannot be replaced with PE wires. The braid should be copper or tin plated copper, and have a cross sectional area of $6mm^2$ or greater.

5.6.8 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.
- All cable routing in an enclosure should be as mounted close as possible to a gear tray or grounded cabinet walls; “free-floating cables” act as both active and passive antennae.
- Use twisted pair wires for analogue and control level wherever possible to prevent interference from radiated common mode noise sources. Continue the twist as close as possible to terminals, and for 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. Do not mix 415 V AC with 24 Vdc, analogue, digital.
- If plastic trunking/ducting is used, secure it directly to installation plates or the framework. Do not allow spans over free air which could form an antenna.
- Keep shield pigtails as short as possible and note they are less effective than full clamping
- Allow no breaks in the cable shields.
- Cabinet Earth connections should be as short as possible using flat strip, multi-stranded or braided flexible conductors for low RFI impedance.
- Avoid coiling excess lengths of Motor Armature cables (particularly with Hiperface DSL Motors).
- Ensure that all Hiperface DSL Motor cables are separated from each other where feasible.

5.6.9 Hiperface DSL Segment Shield Clamping

The ANCA Motion Hiperface DSL Motor Cable Assembly range is designed to be used with an AMD5x Drive fitted with HDLS Encoder support and an ANCA Motion Motor fitted with a Hiperface DSL Encoder.

The Cable Assembly is supplied with wire designator labels. The Cable Assembly range includes variants with an optional Brake Segment and variants to suit termination to the full AMD5x Drive range (3/6/12/20 A, 35 A).

Two exposed shielded braid areas on the Hiperface DSL Cable Assembly support the separate clamping of the Outer Shield and Hiperface DSL Segment Shield at the Drive Gear Tray, adjacent to the top face of the Drive. Both shields carry significant RF Noise Current and both shields must be terminated to an effective RF Ground, which is normally formed by the Equipment Cabinet Gear Tray (refer to *11.8.9 Motor Power Cable Shield Clamps* for details of the recommended Hiperface DSL Segment EMC Shield Clamp).

All AMD5x Drives use the same EMC Clamp for the Outer Shield (ICN-3049-0522) and the same EMC Clamp for the Hiperface DSL Segment Shield (ICN-3049-0523).

Local strain relief for the motor power cable should be fitted immediately after the cable is inserted into the EMC Clamps.

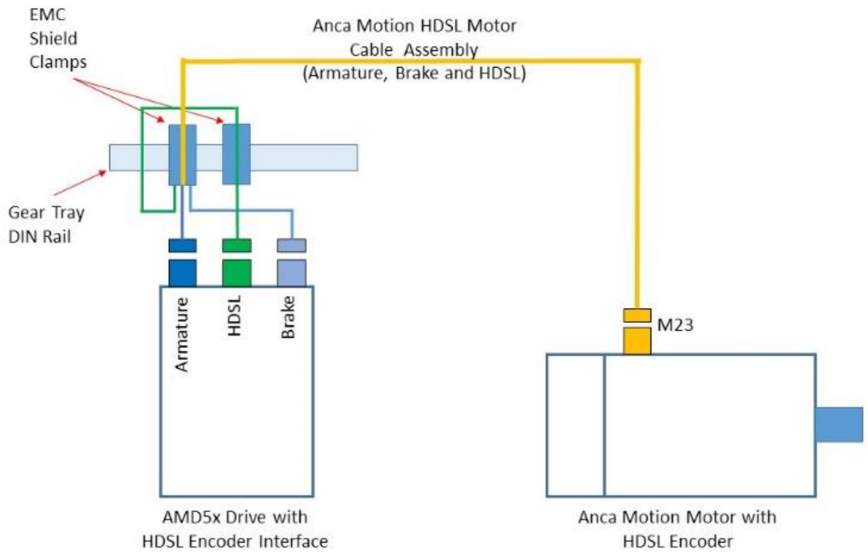


Figure 5-11: Hiperface DSL Cable Assembly: Drive Interface

The nominal placement of the EMC Shield Clamps is dependent on the AMD5x Drive variant (refer to *Figure 5-12*):

- Duct/Recessed Mount: The Outer Shield and Hiperface DSL Segment Shield EMC Clamps must be co-located at the Gear Tray DIN Rail, which would normally both be placed **100 mm** (D1, D3) above the top face of the Drive. The EMC Shield Clamps for the Outer Shield and Hiperface DSL Segment Shields should normally be separated by at least **25 mm** (D2) on the Gear Tray.
- Wall Mount: The Outer Shield and Hiperface DSL Segment Shield EMC Clamps must be co-located at the Gear Tray DIN Rail, which would normally be placed **100 mm** (D1) and **80 mm** (D3) above the top face of the Drive. The EMC Shield Clamps for the Outer Shield and Hiperface DSL Segment Shields should normally be separated by at least **25 mm** (D2) on the Gear Tray.

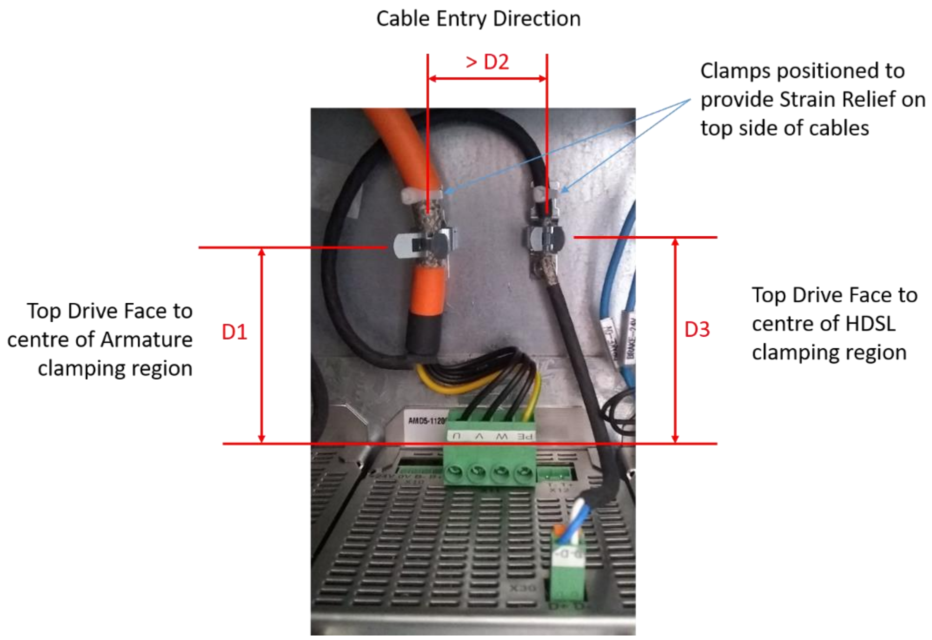


Figure 5-12: Sample EMC Clamp Positioning and Shield Termination

5.6.10 Shielded Hiperface DSL Armature Cable

Shielded Hiperface DSL armature cable schematic for Gamma Motors is shown in *Figure 5-13* with connector pin identification. K5B-DSMD cable variant catalogue numbers can be found in *11.8.7 Shielded Hiperface DSL Armature Cables for Gamma Motors*. An example installation of the Hiperface DSL armature cable is shown in *Figure 5-11.*

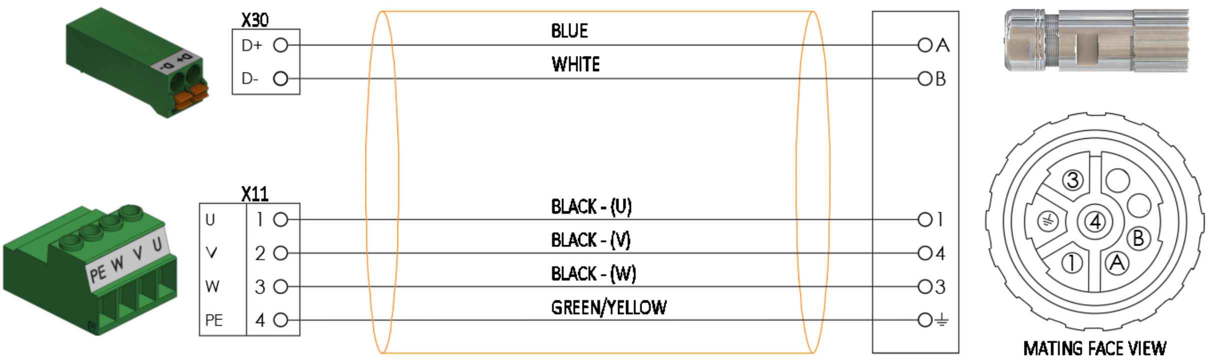


Figure 5-13: K5B-DSMD schematic and connector pin identification

5.6.11 Shielded Hiperface DSL Armature Cable with Brake

Shielded Hiperface DSL armature cable with brake schematic for Gamma Motors is shown in with connector pin identification. K5B-HSMD cable variant catalogue numbers can be found in *11.8.6 Shielded Hiperface DSL Armature Cables for Gamma Motors with Brake*. An example installation of the Hiperface DSL armature cable is shown in *Figure 5-11.*

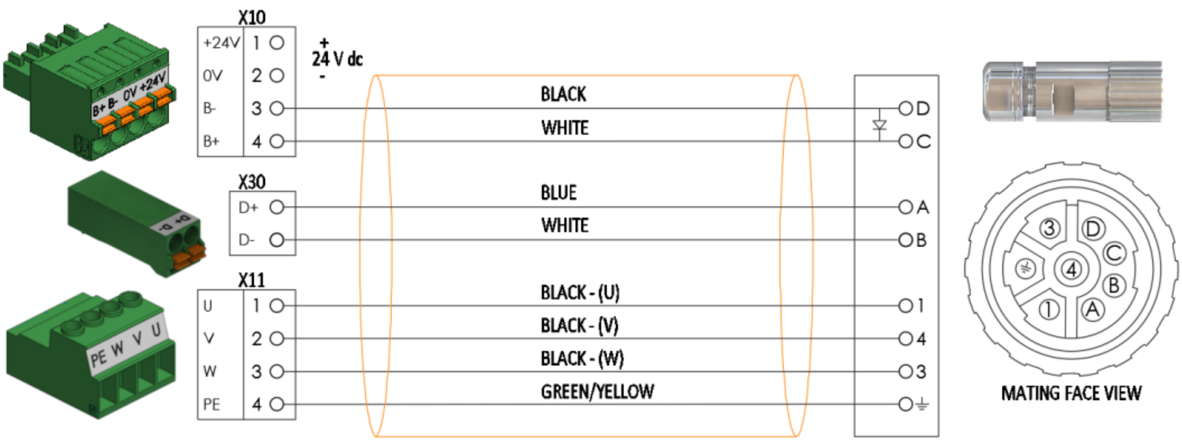


Figure 5-14: K5B-HSMD schematic and connector pin identification

5.7 Motor Brake Connection

Some motors utilise a brake to prevent motor movement when power is removed. The motor's brake must be wired up to the Drive brake connector X10 (shown in *Figure 5-16*), and supplied by the customer's 24 Vdc referenced to the same ground as the 24 Vdc supplied to PIU X7. The 24 Vdc power supply for the brake must be a separate supply to the 24 Vdc supplied to PIU X7 (Refer to *6.3, 24 Vdc Control Circuit* Supply) as brake wires are part of noisy motor cables, and the brake relay may generate a large voltage spike which may affect other devices connected to the brake supply. The Motor Brake must be wired with a protective fly-back diode (typically 1A, 100V) as shown in *Figure 5-15* to prevent damage to the output circuit within the Drive.

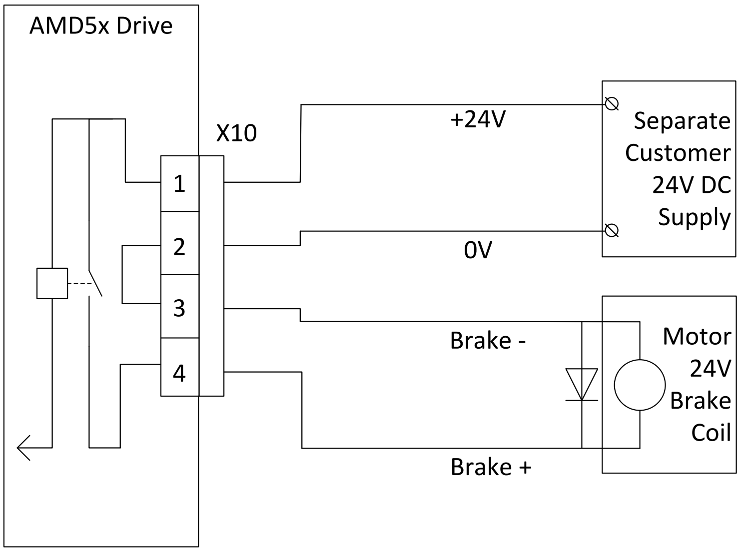


Figure 5-15: Motor Brake Interface Circuit

To engage the brake:

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

To disengage the brake:

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

The AMD5x drive contains a configurable brake release delay after the motor is enabled to prevent undesired movement, refer to the *AMD5x Series Servo Drive – SoE Configuration Guide* for more information. It may be 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. Removal of 24 Vdc to the motor brake will cause the brake to engage.

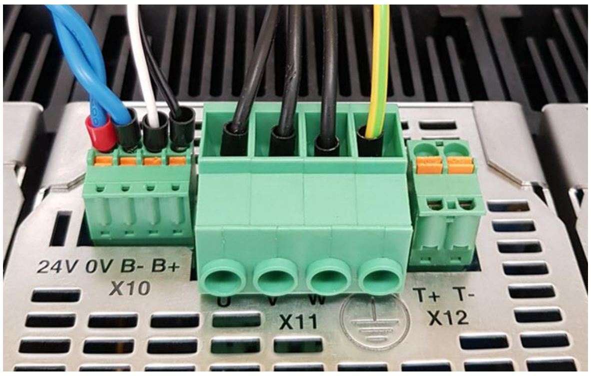


Figure 5-16:AMD5x Drive motor brake connector installation

5.7.1 Shielded Armature Cable with Brake

Shielded armature cable with brake schematic for Beta and Gamma Motors is shown in *Figure 5-17* with connector pin identification. K5B-BSMD cable variant catalogue numbers can be found in *11.8.4 Shielded Armature Cables for Beta/Gamma Motors with Brake*. An example installation of the armature cable with brake is shown in *Figure 5-16.*

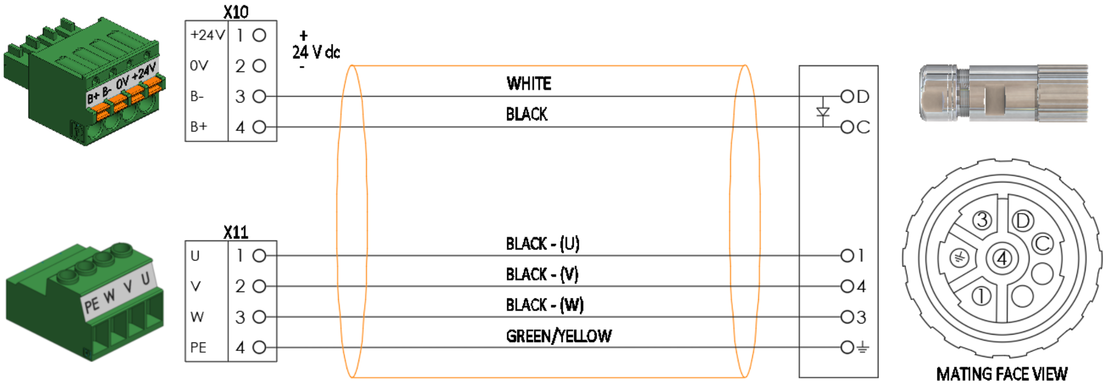


Figure 5-17: K5B-BSMD schematic and connector pin identification

5.8 Motor Thermal Sensor

The AMD5x Drive employs a fully isolated input circuit to receive the signal from a KTY84/130 temperature sensor, which is embedded in the motor windings. This input circuit complies with LVD requirements to assume that the temperature sensor itself may under some circumstances be live at the full armature voltage potential. This drive isolator relieves the requirement to achieve reinforced isolation of the motor sensor and associated wiring.

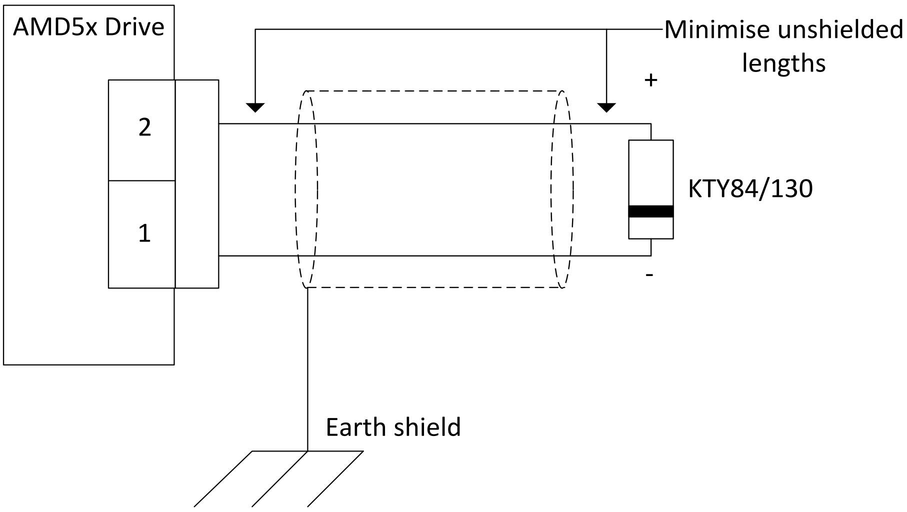


Figure 5-18:AMD5x Drive Motor Thermal Sensor X12

NOTE: The KTY84/130 sensor is polarised, and should be connected with the polarity shown in *Figure 5-18, Figure 5-19* and *3.7.3 X12 – Motor Temperature Sensor Input*

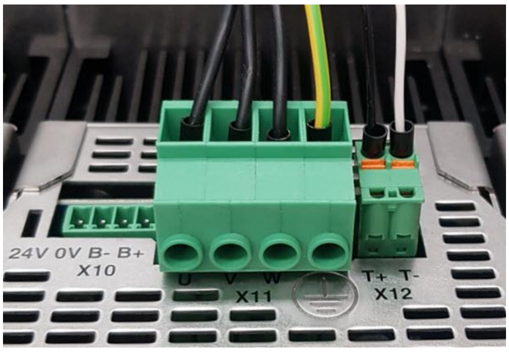


Figure 5-19:AMD5x Drive motor thermal sensor installation

For ANCA Motion Motors fitted with Hiperface DSL Encoders, the Temperature Sensor information is communicated to the AMD5x Drive through the Hiperface DSL Encoder communications channel, rather than via the separate Thermal Sensor interface connector.

5.8.1 Shielded Armature Cable with Thermal Sensor Schematic

Shielded armature cable with thermal sensor schematics for Beta and Gamma Motors are shown in *Figure 5-20* and *Figure 5-21* with connector pin identification. K5B-TSMD-020 and K5B-T2ND cable variant catalogue numbers can be found in *11.8.3 Shielded Armature Cable for Beta/Gamma Motors with Thermal Sensor*. An example installation of the armature cable with thermal sensor can be found in *Figure 5-19.*

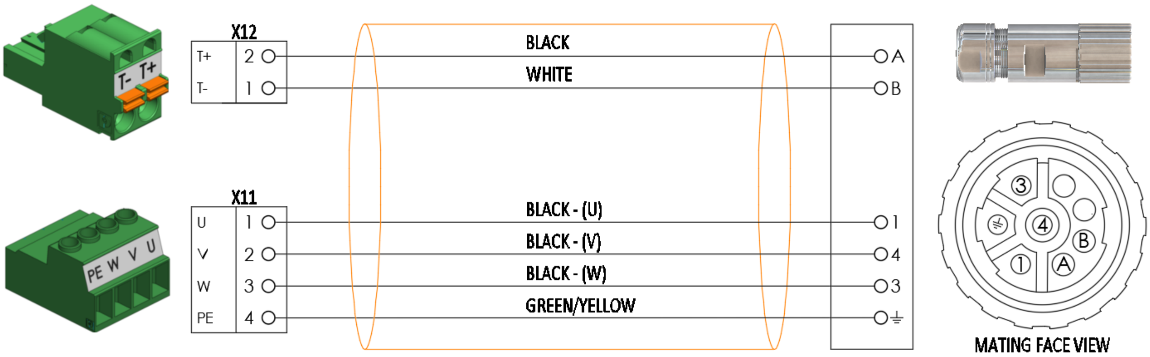


Figure 5-20: K5B-TSMD schematic and connector pin identification

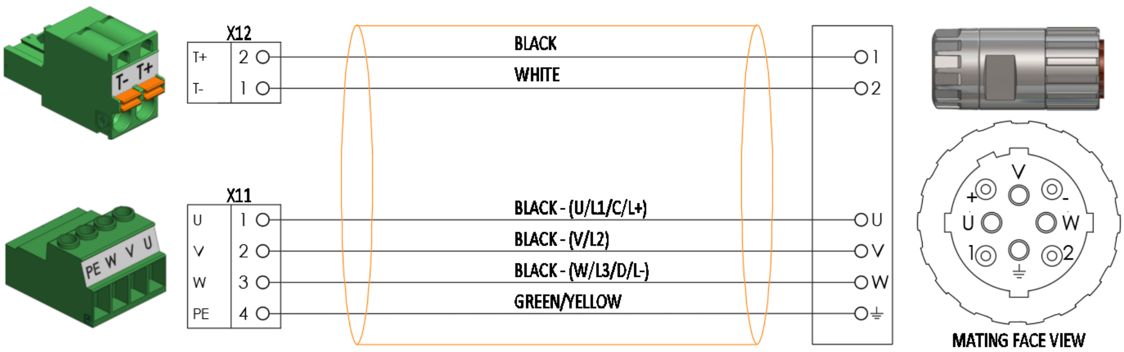


Figure 5-21: K5B-T2ND schematic and connector pin identification

5.8.2 Shielded Armature Cable with Brake and Thermal Sensor

Shielded armature cable with brake and thermal sensor schematic for Beta and Gamma Motors is shown in *Figure 5-22* with connector pin identification. K5B-SSMD cable variant catalogue numbers can be found in *11.8.5 Shielded Armature Cables for Beta/Gamma Motors with Brake and Thermal Sensor*. An example installation of the armature cable with brake is shown in *Figure 5-16* and an example of thermal sensor installation is shown in *Figure 5-19*.

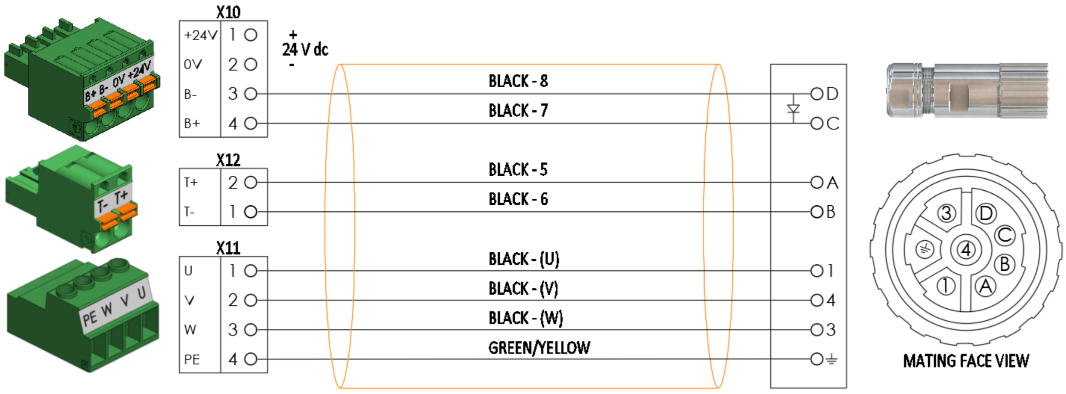


Figure 5-22: K5B-SSMD schematic and connector pin identification

5.9 Regeneration

Regeneration (Regen) refers to the process whereby a decelerating (braking) motor acts as a generator, and kinetic energy of the associated mechanical system is regenerated back through the drive into the common DC Bus as electrical energy. The DC Bus capacitors in the PIU, Drives & Capacitor Modules are capable of storing a limited amount of this energy as the DC Bus voltage rises. To prevent equipment damage to the common DC Bus, voltage rise is clamped at 806V by the PIU which connects a resistor across the common DC Bus, and further regenerative energy is dumped into the resistor.

5.9.1 Regenerative Brake Resistor

Figure 5-23 shows the Regenerative Brake Resistor components. The PIU contains an IGBT which automatically connects the external resistor across the DC Bus to clamp the voltage rise during regeneration, or to discharge the DC Bus when the PIU detects a fault. All resistor energy is dissipated as heat to the environment. During regeneration the connection of the brake resistor causes the DC Bus voltage to drop until at 786V the regen resistor is switched off. If regeneration is still present the DC Bus voltage will rise until at 806V the regen resistor is turned on again. This 20V hysteretic control results in the DC Bus voltage bouncing between 786V & 806V during the regeneration cycle. However, it is important that the Brake Resistor has the appropriate resistance for the application. If the Brake Resistor is not capable of absorbing the amount of peak regenerated power, then the voltage will continue to rise and an overvoltage trip will occur. The selection of the appropriate resistance value for the Brake Resistor is dependent on the application AND the PIU rating.

The regenerative Brake Resistor for the 15kW PIU can have a resistance range of between 36Ω and 18Ω, which results in a peak resistor power dissipation of 18kW (for 36Ω), or 36kW (for 18Ω) when the DC Bus rises above 806V. Use a preferred value of 36Ω unless the peak power of 18kW is insufficient for the application.

The regenerative Brake Resistor for the 24kW PIU can have a resistance of between 36Ω and 9Ω, which results in a peak resistor power dissipation of 18kW (for 36Ω), or as much as 72kW (for 9Ω) when the DC Bus rises above 806V. Use a preferred valued of 18Ω (36kW) unless the peak power of 36kW is insufficient for the application.

NOTE: The Brake Resistor peak power dissipation is quite different to the continuous rms dissipation. For example, in a given application, it is quite possible to require a peak power capability of 36kW, and have a continuous rms resistor dissipation of 3kW. In selecting and sizing the Brake Resistor, BOTH the peak power capability AND the continuous rms capability must be satisfied.

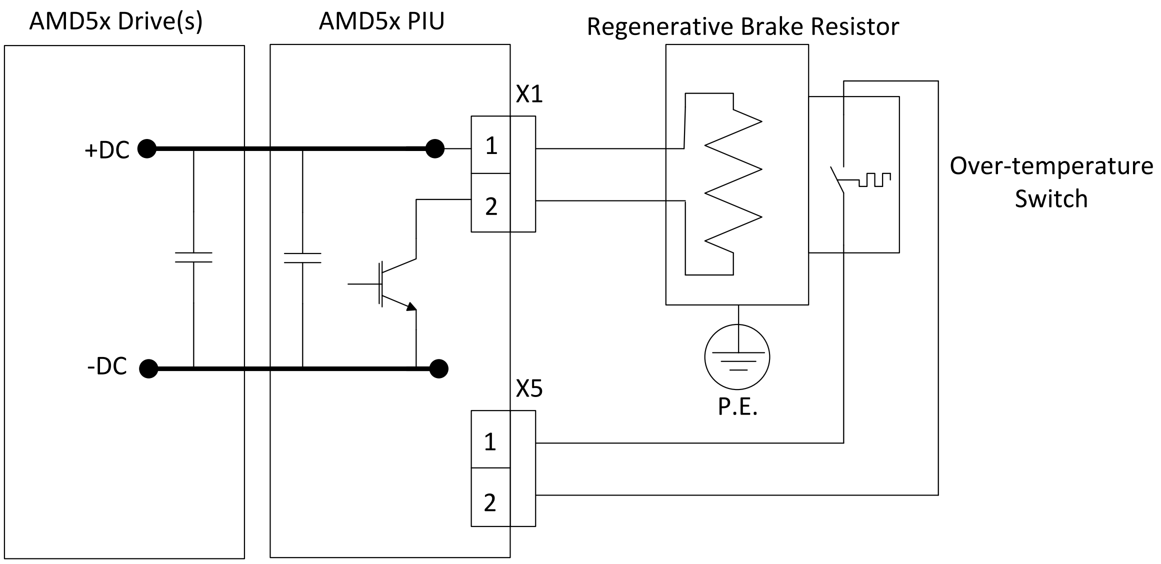


Figure 5-23: Regenerative Brake Resistor Components

Warning: The regeneration resistor can reach high temperatures and should be located with adequate ventilation and with protection against electric shock. Use cables with high temperature insulation rating. Do not allow contaminants such as dust and oil to accumulate on the resistor.

The external regeneration resistor is checked every time the PIU is enabled. Refer to *9.4.3 Regenerative Brake Resistor Test.* The PIU monitors the regeneration resistor current which must be between acceptable limits for the test to pass.

It is recommended to mount the resistor close to PIU connector X1, and use twisted wires of minimal lengths. If the resistor and wiring is not installed in an enclosed cabinet, it is recommended to use shielded cable to enable compliance with EMC emission standards.

The regeneration resistor must connect to X1. Refer to *3.6.1 X1 – Regenerative Brake Resistor*

Danger: Do not short circuit both terminals of connector X1. Voltages up to 900V may occur at X1 terminals. Use connecting cable with sufficient voltage insulation that conform to the requirements and applicable safety regulations of the region of operation.

The regeneration resistor must be installed and cooled so it can dissipate the heat sufficiently. Materials near the resistor must not be flammable. The resistor must be protected from thermal overload by a normally closed (N/C) thermal switch which can be mounted on the body of the resistor. The thermal switch may be supplied internal to the resistor. Refer to *3.6.3 X5 – Regenerative Brake Resistor Over-Temperature Switch.* For resistors which are user accessible a low temperature switch is recommended such as accessory *11.7.2 - Regen Resistor Over-Temperature Switch.* Note a low trip temperature limits the average kW capability of the resistor. Non-accessible installations may use much higher temperature switches resulting in much higher resistor surface temperatures and thus higher kW capability.

The regeneration resistor must be able to sustain 3 electrical load conditions:

- Discharge of the DC Bus, which depends on the total bus capacitance energy, and occurs only when the PIU is turned off.
- The peak power listed in *5.9.1 Regenerative Brake Resistor* which depends on the resistor value.
- The rms power during regeneration, which depends on the application cycle characteristics. The resistor wattage rating should be greater than this value.

5.9.2 Capacitor Module

The AMD5x Capacitor module is used to increase the DC Bus capacitance and allows regenerative energy to be stored and reused. Each module has a capacitance of 2115µF, with greater energy storage capability at lower mains voltage. The modules are connected directly to the AMD5x system DC Bus. No pre-charging is necessary as the PIU is capable of soft charging the DC Bus with the capacitor modules connected. A maximum of 4 capacitor modules can be installed on the AMD5x system.

For occasional and low energy applications the brake resistor can be used to dissipate the regenerative energy.

For continuous/regularly repeated or high energy applications Capacitor Modules should be added to prevent regeneration energy being discharged into the braking resistor. The initial equipment investment can be recouped by electricity supply savings.

Note: At least one Capacitor Module is required when employing the 24kW PIU (AMD5-P6240-_____).

The capacitor module also has the following advantages:

- Decreases ripple current in capacitors, thus reducing capacitor temperature and increases component lifetime
- Increased mains brownout ride through
- Less regenerative energy dumped, thus lower cost of smaller resistor and less problem of removing dissipated heat

The capacitor module is mounted at the right-hand end of the AMD5x system Refer *to 4.4.4 Mounting a Capacitor Module*

5.9.3 Regenerative Energy Calculations

Regeneration energy is entirely dependent on the multi-axis drive application where one or more drives can contribute to the regenerative energy. The applications must consider all the moved masses, velocity, deceleration, losses from gearbox & motor resistance.

The kinetic energy of the system can be calculated from the Linear and Rotational movement equations:
Linear Movement:

$E_M = ½\, m\, v^2$
Where E_M = Energy in (Joules)
m = motor & load mass (kg)
v = velocity (m/s)

Rotational Movement:

$E_J = ½\, J\, \omega^2$
Where E_J = Energy in (Joules)
J = motor & load moment of inertia ($kgm^{2)}$
ω = angular velocity (rad/s)

Mechanical systems should consider the combined effects of linear movement (e.g. gantry) and rotational movement of the driving motor + gearbox.

System losses such as motor resistance are subtracted from the kinetic energy:
Motor Winding Losses:

$E_W = 3\, I^2_M\, R_M\, t_D$
Where E_W = Motor winding loss energy (Joules)
I_M = motor current during deceleration (Arms/phase)
R_M = motor resistance (Ω Phase-Phase)
t_D = deceleration time (sec)

Thus kinetic energy regenerated to the DC Bus is simply: $E_B = E_M + E_J - E_W$

The electrical energy the DC Bus capacitors can absorb can be calculated from:
DC Bus Capacitor Energy:

$E_C = ½\, C\, (V^2_M - V^2_{NOM})$
Where E_C = Capacitor energy in Joules
V_M = maximum bus voltage (806V)
V_{NOM} = Nominal bus voltage = $U_{LL\text{-}(3\,\Phi)}\sqrt{2}$
C = Total Bus Capacitance in Farads

If the kinetic energy (E_B) is greater than the DC Bus Capacitor Energy (E_C) then the brake resistor will be required to dissipate the excess energy.

Example 1:
A 4 axis gantry system moving in one axis, decelerates from 2m/s to stop in 0.136s. The motor is rotating at 2790rpm when deceleration begins. The full movement cycle takes 0.5s

Gantry mechanical system: mass = 520kg; v = 2(m/s), t_D = 0.136 (sec)
Electrical motor: R_M = 0.15Ω, I_M = 32A_{RMS}, J = 0.0088 kg/m^2,

Electrical system: Refer to *10.4.1 AMD5x PIUs* and *10.4.2 Drives* for drive capacitance specifications.
AMD5x PIU(705µF) + 2 x 35A drives(270µF each) + 1 x 20A drive(135µF) + 1 x 12A drive(135µF) , thus total bus capacitance = 1,515µF
Mains 3 phase line-line voltage: 380V, thus V_{NOM} = 537V, thus E_C= 273J

Thus E_M = 1040J, E_J = 376J, E_W = 63J.
The kinetic energy into DC Bus: (1040 + 376 - 63) = 1353J
Thus dissipated brake resistor is 1353-273 =1080J for each deceleration.
The average resistor power is 1080/0.5 = 2160W. The selected resistor wattage rating should be greater than this value.
Required resistor power during regeneration is 1080/0.136 = 7.9kW, which is less than the peak power (18kW) of a 36Ω resistor, so this 36Ω resistor can brake the kinetic energy.

During a PIU shutdown the DC Bus is fully discharged into the brake resistor, which must be able to dissipate this energy $E_C = ½\, C\, V^2_M$ = 492J. For a 36Ω regen resistor and total capacitance of 1,515µF, the discharge has an exponential decay of time constant τ = 36 x 1,515 = 55ms.The equivalent rectangular power (18kW) pulse has duration of $\tau/2$ = 27ms.

If in Example 1 three capacitor modules were added to the AMD5x system, then total bus capacitance = 7,860µF and thus E_C= 1418J. Since the capacitor energy is greater than kinetic energy, no energy will be dissipated into the brake resistor. This can present considerable energy cost savings, and the resistor wattage rating is much lower.

With three capacitor modules, the brake resistor must be able to dissipate $E_C = ½ C V^2_M$ = 2553J when the PIU bus is discharged during a shut down. With a 36Ω Brake Resistor, the resistor and total capacitance discharges with exponential decay of time constant τ = 36 x 7860 = 283ms which equates to a rectangular power pulse of 18kW for duration of $\tau/2$ = 141ms. The brake resistor must have an energy rating greater than this single discharge pulse. The three capacitor modules require the brake resistor to have minimal wattage rating, but higher pulse power rating.

5.10 DC Busbar and PE Terminals

Danger – High Voltage Area: If you require access to the Busbar screw terminals ensure that the DC Bus capacitors have been fully discharged. Refer to the Product Rating Sticker on the side of the drive for further information. Refer *1 Safety*

The AMD5x PIU and Drives utilise a common DC Bus where power is supplied from the PIU and distributed to all Drives connected on the same bus. The Protective Earth bus runs parallel to the DC Bus and uses the same busbars to connect between Drives and PIU. Longer Busbars are supplied with “Wide” Drives (the 35A and 35AH).

Warning: **The M4 nuts holding the busbars must be tightend to 1.5Nm**

Warning: **Ensure all busbars are installed before applying mains power to the AMD5x system.**

5.11 Checking the Insulation of the Assembly

The Installed three-phase supply and motor cables must be tested for functioning insulation according to local regulations by using an insulation resistance tester at 500Vdc.

The AMD5x PIU and Drives have internal voltage surge suppression components fitted to reduce EMI originating from switching of high power internal components. When carrying out an insulation resistance test (megohmmeter) on an installation in which the AMD5x PIU and Drive is fitted, the internal voltage surge suppression components may cause the test to fail, and potentially damage the PIU and/or Drive. To accommodate the insulation resistance test, the cables **must** be disconnected from the PIU and Drive, before the insulation resistance test is carried out on the cables.

The cables to be disconnected are: three-phase supply (X2 on PIU), regenerative brake resistor connector (X1 on PIU) and motor connector (X11 on Drive).

5.11.1 Checking the Regenerative Brake Resistor Insulation

The resistor must be disconnected from X1 on the PIU and mounted in the electrical cabinet.
The external regeneration resistor must be tested for functioning insulation according to local regulations by using an insulation resistance tester at 1000V. Both resistor leads must have an insulation resistance greater than 1 MegOhm to the Protective Earth conductor. A test should also be carried out to ensure that the resistance of the regeneration resistor is as expected.

6 Control Wiring

6.1 What This Chapter Contains

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

- 24 Vdc Control Circuit
- EtherCAT
- Motor Feedback

6.2 Control Cable Routing

There are three main categories of cabling for the drive.

- **Motor power 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, temperature sensors) or running information between drives or to other control units on the machine (e.g. Digital Output to an external Transducer)
- **Power Supply Cables**: Three phase mains supply cables to the PIU. Regen Resistor cable

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 Vdc and mains/drive cables be routed in separate ducts. Where this is not possible, the 24 Vdc cable should be appropriately insulated for 1000V.

6.3 24 Vdc Control Circuit Supply

The AMD5x requires an external 24 Vdc supply to power all control circuits in the PIU and Drives. This supply is connected to PIU with connector X7. *Refer 3.6.5 X7 – 24 Vdc Supply*.

The 24 Vdc is distributed via a ribbon cable from the PIU to all the Drives. Each Drive uses one connector to draw control power from the ribbon cable bus. The ribbon cable has a folded arrangement with widths and length specific to the number and types of Drives. *Consult ANCA Motion* to supply the correct ribbon cable arrangement. The folded ribbon cable simplifies the removal of Drives and removes the risk of poor contacts associated with screwed control bus-bars. In order to remove a Drive, the ribbon cable must also be unplugged from the Drives (or PIU) to the left and right from the removed Drive. The ribbon cable can be still connected to other Drives and the unfolded length provides plenty of room to remove the Drive.

The AMD5x has diode polarity protection on the PIU and each Drive to prevent reverse currents from flowing and damaging circuitry. As part of this protection system, the PIU has a high capacity earth which internally connects the 0V of the 24 Vdc control supply to the protective earth (metal cabinet). If the supply to X7 is connected with reverse polarity a short circuit will be generated to the external 24 Vdc supply. The customer 24 Vdc control supply must also be earthed in the system machine cabinet.

Warning: The 0V terminal of X7 (pin2) is internally connected to the protective earth (metal cabinet). Ensure the 0V of external 24 Vdc supply is also grounded.

The current demand of the 24 Vdc supply must be sized on the number and types of Drives, types of encoders, and additional loads such as probes. A conservative estimate is 0.3 A for the PIU and 1 A for each Drive. This is based on two high current encoders and both Proximity Switches being used.

In practice, a closer estimate can be made based upon the following:

- PIU base load: 0.27 A
- Each Fan current: 0.27 A (refer *10.5.5 Wall and Recessed Cooling* for number of fans for each product).
- Drive base load: 0.27 A (with no Encoders or Proximity Switches connected)
- Encoder current: 0.28 A

Example Wall Mount system with: PIU, 35A, 20A, 12A. The 20A drive has two encoders, while all other drives have one encoder. The 12A drive has one Probe fitted rated 100mA @24 V. See Table 256 for calculation.

Table 26: Example 24 Vdc supply calculation

AMD5x Module	Base load current (A)	Module Fan current (A)	Encoder current (A)*	Probe current (A)	Total module current (A)
PIU	0.27	0.27	0	0	0.54
35A	0.27	0.81	0.07	0	1.15
20A	0.27	0.54	0.14	0	0.95
12A	0.27	0.27	0.07	0.1	0.71
Total 24 Vdc system current (A):					**3.35**

*This column shows the reflected current load on the 24VDC supply. This current is ¼ of the actual Encoder currents, due to the SMPS step-down. The actual Encoder currents are 0.28A per 5V Encoder in this example.

Note a duct mount system will have no fan module current.
The maximum allowed 24 Vdc system current is 10A on the PIU connector X7.

6.3.1 Fan Operation on Wall and Recessed Mount Drives

All Wall and Recesssed mounted Drives have one or more heatsink cooling fans. (refer *10.5.5 Wall and Recessed Cooling* for number fans for each product). The fans will perform a power on self test for 10 seconds after 24 Vdc is applied to the Drive system and upon system connection to the EtherCAT master.

After the 10 seconds start-up sequence has been completed, the fan speed will be based on the Drive or PIU cooling needs.

6.4 Ethernet Interface

6.4.1 EtherCAT®[1]

AMD5x supports the EtherCAT protocol with ‘Servo Profile over EtherCAT’ (SoE). 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 AMD5x and other EtherCAT enabled controllers.

AMD5x 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.

6.4.2 EtherCAT Topology / Port Assignment

Each AMD5x PIU and Drive utilises the EtherCAT system topology as shown in *Figure 6-1*.

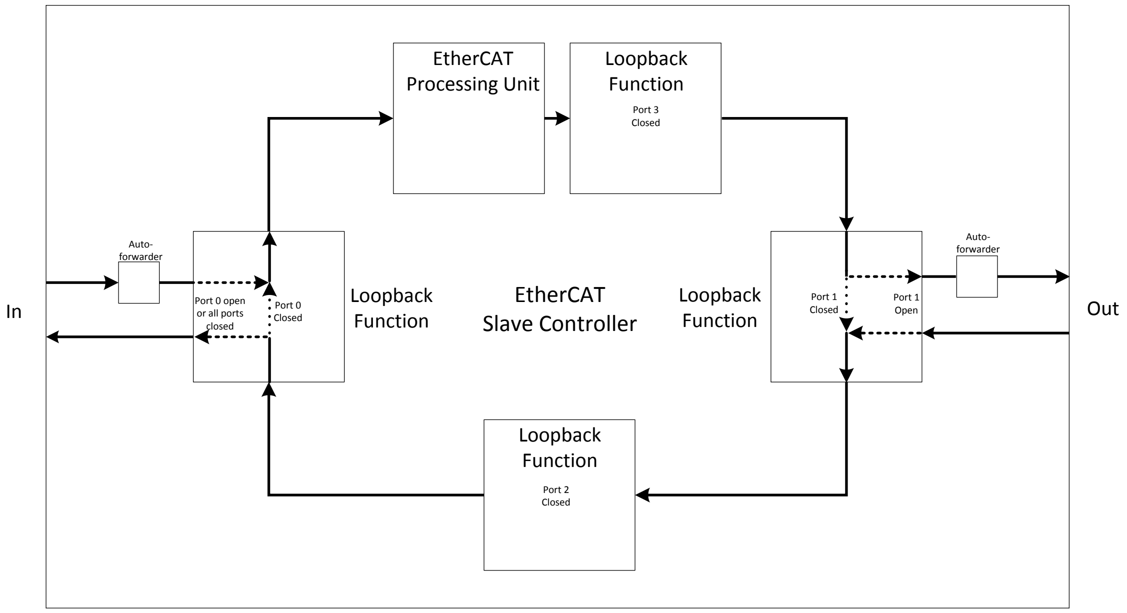


Figure 6-1: EtherCAT system topology

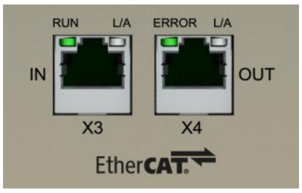
1 EtherCAT® is a registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany

6.4.2.1 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.

6.4.2.2 EtherCAT Connectors

PIU X3/X4 EtherCAT IN/OUT connectors.

	X3	EtherCAT IN
	X4	EtherCAT OUT

Drive X17/X18 EtherCAT IN/OUT connectors.

	X17	EtherCAT IN
	X18	EtherCAT OUT

6.4.2.3 EtherCAT Cables

To connect the AMD5x drive and PIU to other EtherCAT devices the following types of cables must be used with Ethernet 8P8C modular connectors. They are commonly referred to as “RJ45 shielded patch leads”.

Table 27: EtherCAT Cables

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

- TP = Twisted Pair
- U = Unscreened pairs
- F = Foil
- S = Screened (Braid type)

Either straight or crossover cables may be used.

Refer *11.5 EtherCAT®* Cables for suitable cables

6.5 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 AMD5x drive.

6.5.1 Analogue Encoder Interface signals

The AMD5x Drives have provision for two Analog Encoder Inputs. Refer *3.7.4 X13 – Encoder 1 Input* for Encoder 1 pin assignment, and *3.7.5 X14 – Encoder 2 Input* for Encoder 2 pin assignment.

The left hand Encoder 1 channel (X13) accepts Incremental 1 Vpp signals as well as 1 Vpp Commutation (Comm) Track signals. The right hand Encoder 2 channel (X14) also accepts Incremental 1 Vpp signals, but does not have a provision for Comm Track signals. Both Encoder 1 and Encoder 2 inputs convert Incremental signals to QEP ("digital" version) signals for use by the AMD5x DSP QEP counters.

These incremental and Comm Track signal inputs are differential, with an input impedance of 120 Ohms for incremental signals, and 1K Ohms for Comm Track signals. These inputs are tolerant of a range of offset voltages of 1V to 3V, meaning that 3V3 based encoders (offset = 1.65V nom), and 5V encoders (offset = 2.5V nom can be accommodated. Incremental 1 Vpp signals can have a frequency as high as 600kHz, and the combination of encoder and axis speed should be selected to ensure that this frequency is never exceeded.

NOTE: Exceeding 600kHz on Incremental signals can result in poor sine and cosine quality and lost QEP counts, which will cause defective operation.

Both Encoder 1 and Encoder 2 have Reference (index) signal inputs which are also differential, with an input impedance of 120 Ohms which are nominally 1 Vpp, but in fact cover a wide range of Reference pulse formats. The reference pulse detection circuitry essentially detects zero-crossing of the reference pulse input. The reference pulse detection circuitry is compatible with various signal formats such as Renishaw and Tamagawa, as well as the demanding Heidenhain Analogue Encoder.

Encoder cable connections are as per *3.7.4 X13 – Encoder 1 Input* for Encoder 1, and *3.7.5 X14 – Encoder 2 Input* for Encoder 2. It is recommended that the inner shield of a particular Encoder Cable be connected to ENC1_0V or ENC2_0V or Pin 12. This cable inner shield should NOT make contact with the cable outer shield. It is essential that the cable outer shield be connected to only the shell (casing) of the D-SUB connector.

NOTE: Poor or absent shielding connections is the main cause of noise problems within a system. The AMD5x Drives are particularly robust, and have characteristically low noise in Encoder signal processing, but good shielding is nevertheless essential in achieving this robustness.

6.5.2 Analogue Encoder Power Supplies

The AMD5x Drives provides a 5V DC supply to each of the Analog Encoders. Refer *3.7.4 X13 – Encoder 1 Input* for Encoder 1 pin assignment, and *3.7.5 X14 – Encoder 2 Input* for Encoder 2 pin assignment.

These supplies are independently regulated at the "sending end" (the D-SUB connector on the Drive). Regulation is particularly tight, and a voltage of 5.19V nominal is maintained at the respective D-SUB connector.

The maximum supply current per Encoder channel is 500mA, with the aggregate total from both channels not to exceed 500mA. Under all variations of load and temperature, the regulation circuitry ensures that the sending end voltage is between 5.10V and 5.25V.

Since cable compensation is not employed, care should be taken to ensure that cable volt-drop does not result in under-voltage at the Encoder itself. For example, if a tight tolerance Encoder has an acceptable range of 4.75 to 5.25, then maximum total cable drop is 5.10 - 4.75 = 0.35V, at the particular current being drawn.

Each Encoder power supply is also short-circuit protected with solid state current limiting devices which are self-resetting. The encoder power supply is monitored by the DSP and provides low voltage fault detection.

6.5.3 Hiperface DSL Encoder

AMD5x Drives fitted with integrated Hiperface DSL Encoder support provide a core Servo Drive function along with a Hiperface DSL Encoder Interface. This supports the use of a single Motor Cable Assembly between the Motor and the Servo Motor Drive System.
The Hiperface DSL Encoder Interface is accessed via a single, pluggable connector (X30) on the top of the Servo Drive, with the Armature and Brake Interfaces also co-located on the top of the drive. Integral polarisation is provided for the mating connector-plug of the Hiperface DSL Interface connector-header (X30) – also refer to *3.7.9 X30 – Hiperface DSL Encoder Interface.*

The ANCA Motion Hiperface DSL Motor Cable Assembly range is designed to be used with an AMD5x Drive fitted with HDLS Encoder support and an ANCA Motion Motor fitted with a Hiperface DSL Encoder. Two exposed shielded braid areas on the Hiperface DSL Cable Assembly support the separate clamping of the Outer Shield and Hiperface DSL Segment Shield at the Drive Gear Tray, adjacent to the top face of the Drive – also refer to *5.6.9 Hiperface DSL Segment Shield Clamping*.

6.5.4 BiSS/ABZ Encoder

The AMD5x Servo Drive with integrated BiSS Encoder support provides a core Servo Drive function along with a BiSS encoder or ABZ incremental encoder interface. The BiSS or ABZ Encoder Interface is accessed via a single, pluggable connector (X32) on the top of the Servo Drive. Refer *3.7.10 X32 BiSS/ABZ Encoder Input.*

6.5.5 BiSS Functional Safety System

The AMD5x Drive supports BiSS Functional Safety encoders as part of a Functional Safety system (shown in *Figure 6-2*), by allowing the encoder signals to be monitored by an additional BiSS Functional Safety Monitor via pluggable connector (X31) on the top of the servo drive. *3.7.11 X31 BiSS Encoder Functional Safety Output.*
AMD5x drives with BiSS encoders are supplied with a dust plug inserted into the *3.7.7 X16 – Encoder Monitor Output* to prevent incorrect connection of BiSS Functional Safety Monitor cables.

The AMD5x Servo Drive with only the integrated BiSS Functional Safety Encoder does not form a safety rated system.

When connected to a BiSS Functional Safety encoder, the AMD5x Drive uses the Control Position Word (CPW) and ignores the Safety Position Word (SPW) data from the encoder. The SPW and encoder 5V supply is monitored by the BiSS Functional Safety Monitor.

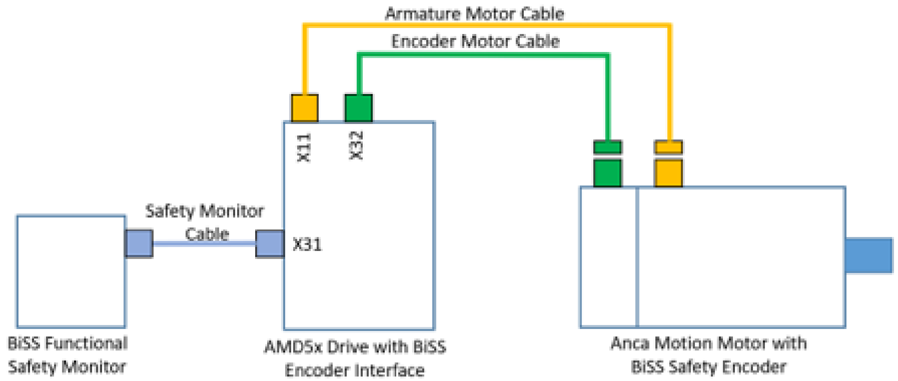


Figure 6-2: BiSS Functional Safety System Topology

6.5.6 BiSS RS-422 Physical Interface

Figure 6-3 shows the hardware interface for both the BiSS encoder and BiSS Functional Safety Monitor that is a RS-422 point to point system with 120ohm termination resistors. The use of two separate RS-422 systems eliminates the need for modifying termination resistors if the BiSS Functional Safety Monitor is not connected. The BiSS Functional Safety Monitor Clock(MA) and Data(SL) signals are buffered with a maximum propagation delay of 12ns, which can be compensated in the BiSS Functional Safety Monitor.

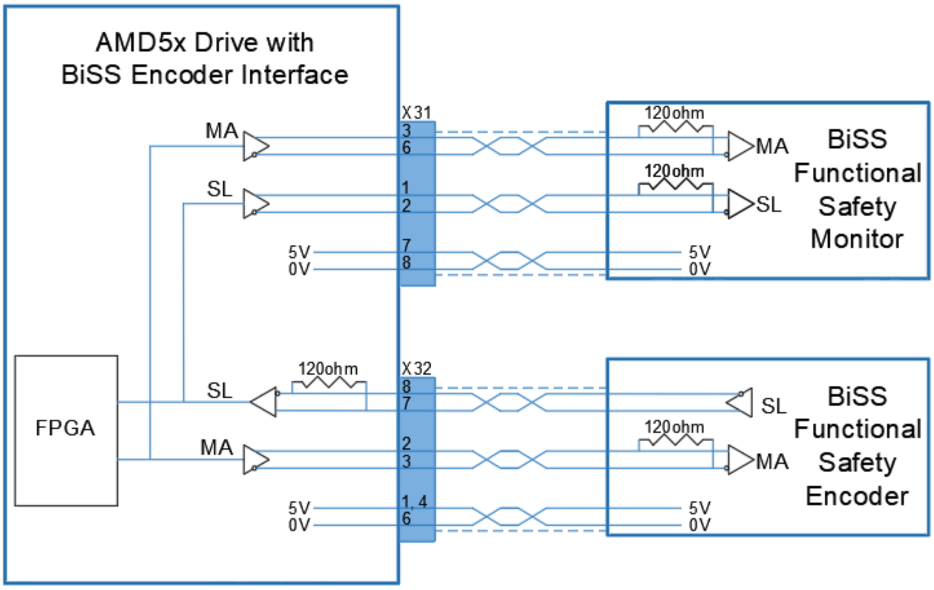


Figure 6-3: AMD5x Drive BiSS RS-422 connections

The RS-422 cables must have the following characteristics:

- Leads for Clock(MA), Data(SL) & 5V shall be twisted pairs.
- Lead for 5V supply should be of sufficient gauge to minimise voltage drop.
- Cable length is less than 30m.
- Entire cable has outer shield.

6.6 Probe Inputs

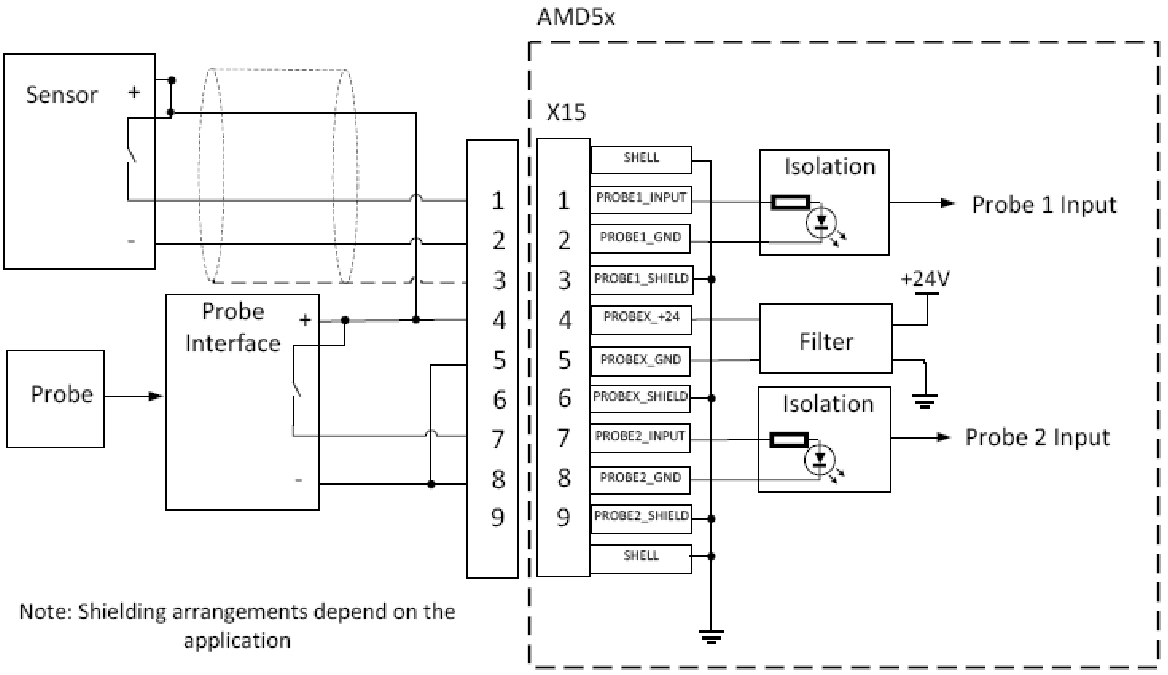
6.6.1 Probe/Proxy Interface and Power Supply

Refer *3.7.6 X15 – Probe 1&2 Input, ProbeX +24 Vdc Probe/Proxy* Feed for pin assignment.

The D-SUB 9-WAY X15 connector on the AMD5x Drive has provision for two separate Probe Inputs and a dedicated 24 Vdc power source intended for use with Probes or Proxy switches. A feature of the 24 Vdc power source not only means that probe/proxy wiring is simplified, but more importantly, noise free probe/proxy operation can be achieved since the 24 Vdc feed is “clean”, and free of noise usually present on general use 24 Vdcsupplies in the electrical cabinet.

The 24 Vdc source (PROBEX designation on X15) is obtained from pins 4, 5, and 6, and can be used to supply either/or both Probe/Proxies. The ProbeX 24 Vdc output is rated at 200mA, and is short-circuit protected (self-resetting fuse). In addition, this 24 Vdc output is monitored by the DSP so that short-circuit faults are detected. The pin assignment accommodates the use of three internally shielded pairs, and one external shield. This cable format is strongly recommended for Probe/Proxy wiring.

A Proxy switch can be used instead of a full Encoder, where only simple speed-sensing is required. The maximum frequency that the drive can monitor through the proxy input is 4000 Hz.

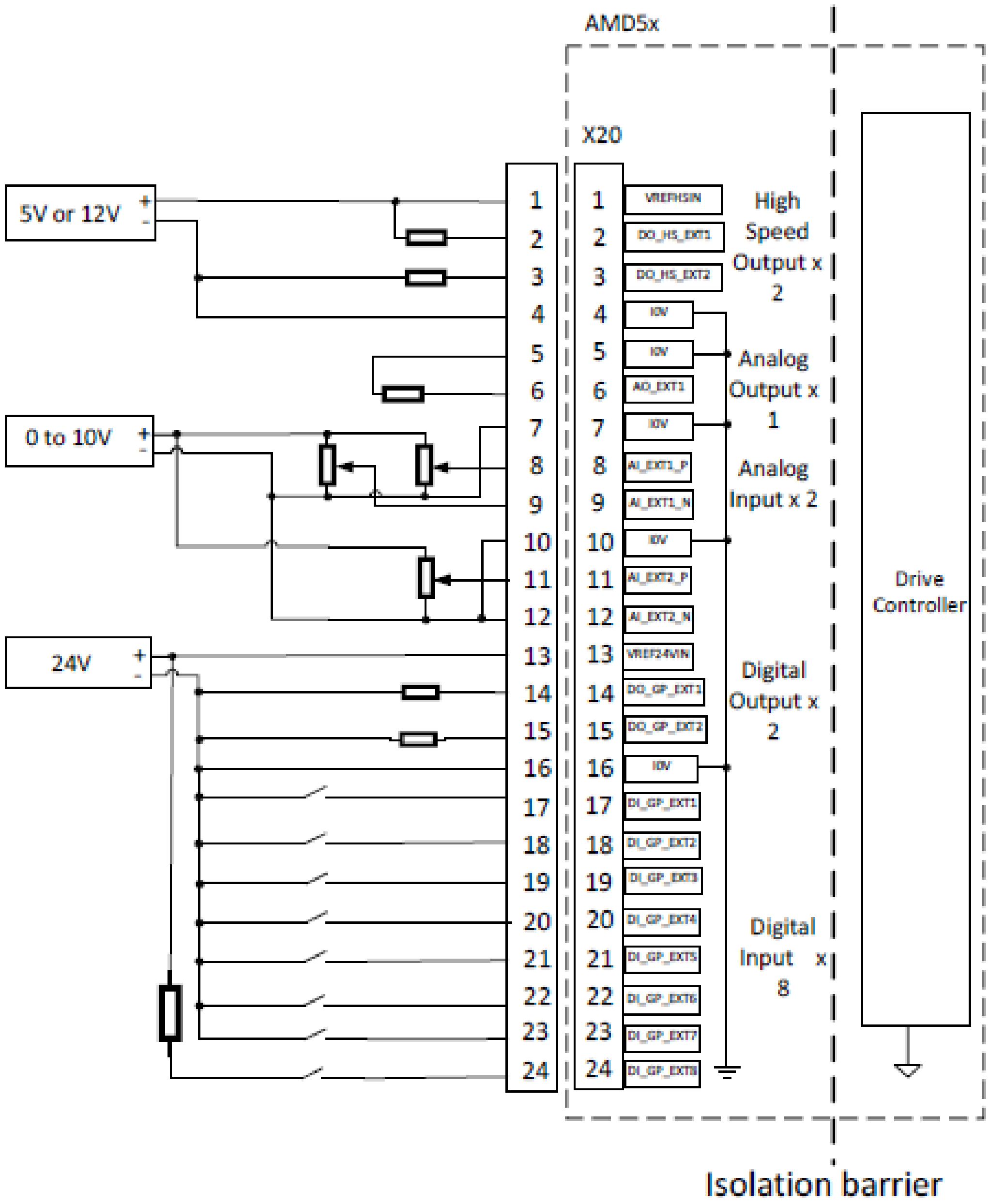


6.7 IO Interface

The AMD5x Servo Drive with an integral IO Interface provides a core Servo Drive function along with a generic Input/Output (IO) Interface to support customer IO requirements. The Drive is used in Servo Motor Drive Systems requiring additional IO control and detection for external transducers and other control/measurement equipment. The IO Interface provides the following IO functions:

Table 28: IO Interface Functions and Channels	
Function	**Channels**
Digital Input: General Purpose	8
Digital Output: High Speed	2
Digital Output: General Purpose	2
Analog Input: Voltage	2
Analog Output	1

The IO interface is accessed via two pluggable connectors on the front face of the Servo Drive (refer to *3.7.9 X30 – Hiperface DSL Encoder Interface*)



6.7.1 X20 – IO Interface for the Associated Pin Assignment

Polarisation is provided for each mating connector-plug via the inclusion of factory fitted Coding Keys (Red) on pins 12 and 13 of the IO Interface connector-header (X20).

For AMD5x Drives supplied with the optional Connector Kit, the two supplied connector-plugs are also provided with the associated pin keys removed. These connector-plugs have a Spring Cage format and support the termination of a wire gauge range of 20 – 26 AWG with a wire strip length of 8 mm, or ferrules with a cross sectional area range of 0.25 – 0.50 mm^2. Ensure the correct wire strip length is used so that the wire insulation is located within the body of the Spring Cage connector, to minimise short circuits between adjacent wires on the connector. It should be noted that the connector format only supports connection of a single wire per pin.

It is recommended that the customer fits the wires/cables assemblies to the connector-plug **prior** to connection to the User Interface.

Functional isolation (between SELV circuits) is provided by the IO Interface from the rest of the Servo Motor Drive system.

Two customer supplied external voltage references are required for the use of the Digital Input and Digital Output subsystems.

An internal power supply supports all other IO Interface functions (including the Analog subsystems).

6.7.2 External Voltage References

The IO Interface requires the use of two external voltage references for operation of specific subsystems:

- VREF24 V: X20/13: Digital Input, General Purpose Digital Output
- VREFHS: X20/1: High Speed Digital Output

The VREF24 Vdc Positive Reference has a nominal value of +24 Vdc, is used for both the General Purpose Digital Output and Digital Input subsystems, and must be connected for correct subsystem operation.

The VREFHS Positive Reference has a nominal range of +5 to +24 Vdc, is only used for the High Speed Digital Output subsystem, and must be connected for correct subsystem operation.

A common Positive Reference of +24 Vdc can be applied to both VREF24 Vdc and VREFHS when the High Speed Digital Output subsystem requires an interface drive level of +24 Vdc.

A common Negative Reference of 0 Vdc is provided across all subsystems.

All Positive and Negative References are functionally isolated (between SELV circuits) from the rest of the AMD5x Drive system. It should be noted that a common Negative Reference (0 Vdc) could be used between the AMD5x Drive (system) and the IO interface, but this could lead to noise related performance issues on some subsystems.

6.7.3 Distribution

The IO Interface provides for effective termination of the external Positive References, the common Negative Reference, and the shields of interconnecting cables.

The distance between the IO Interface Front Panel Connectors and any associated Distribution Terminal Strips should be minimised.

It should also be noted that the IO Interface provide common Negative Reference pins for the Digital Output, Analog Input and Analog Output subsystems.

6.7.4 General Purpose Digital Output

The General Purpose Digital Output subsystem has a Push-Pull output format which allows the Load to either be connected between the Output Pin and the Positive Reference, or between the Output Pin and the Negative Reference.

It should be noted that this subsystem can be used to drive Resistive and Inductive Loads.

An isolated Positive Reference of +24 Vdc is connected to Positive Reference (VREF24 V) for this subsystem.

A typical wiring diagram of the General Purpose Digital Output subsystem is shown in *Figure 6-4: Typical Wiring Diagram: DO-GP and DO-HS*.

6.7.5 High Speed Digital Output

The High Speed Digital Output subsystem has a Push-Pull output format which allows the Load to either be connected between the Output Pin and the Positive Reference, or between the Output Pin and the Negative Reference.

It should be noted that this subsystem can only drive Resistive loads.

An isolated Positive Reference between +5 to +24 Vdc is connected to the Positive Reference (VREFHS) for this subsystem.

A typical wiring diagram of the High Speed Digital Output subsystem is shown in *Figure 6-4: Typical Wiring Diagram: DO-GP and DO-HS*.

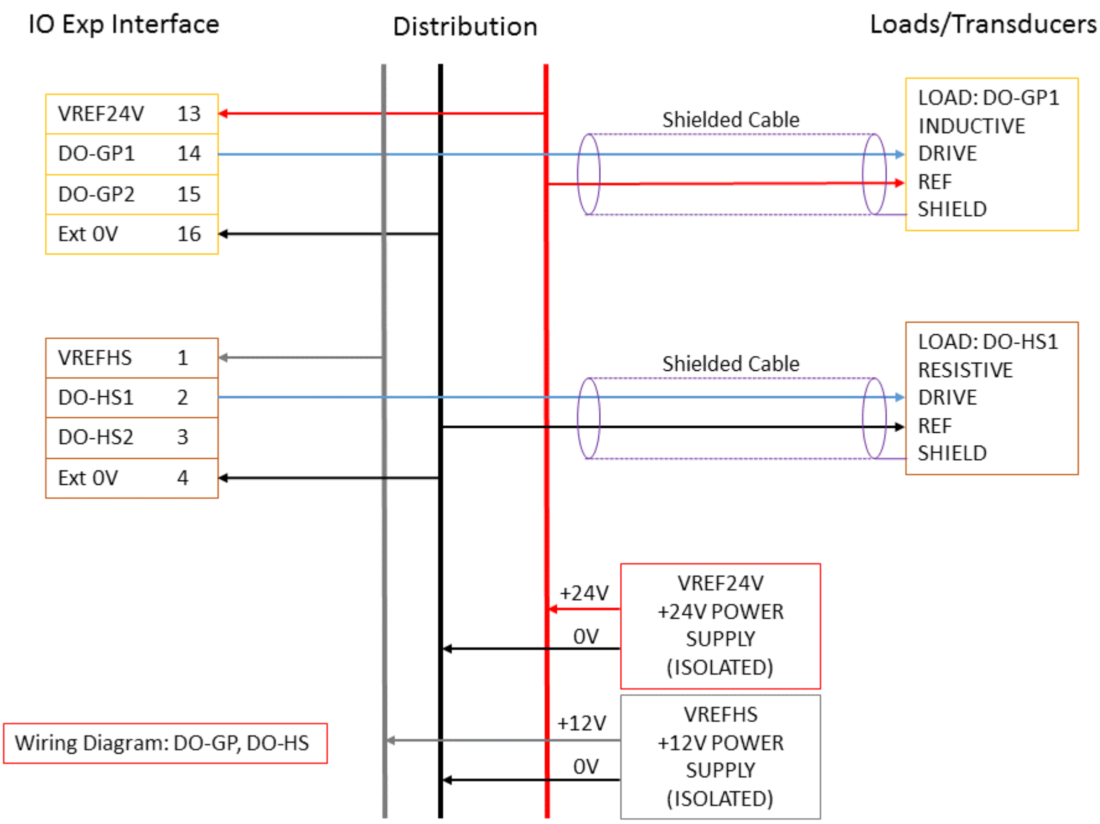


Figure 6-4: Typical Wiring Diagram: DO-GP and DO-HS

6.7.6 Digital Input

An isolated Positive Reference of +24 Vdc is connected to Positive Reference (VREF24 V) for this subsystem.

A typical wiring diagram of a Digital Input subsystem is shown in *Figure 6-5: Typical Wiring Diagram: DI-GP.*

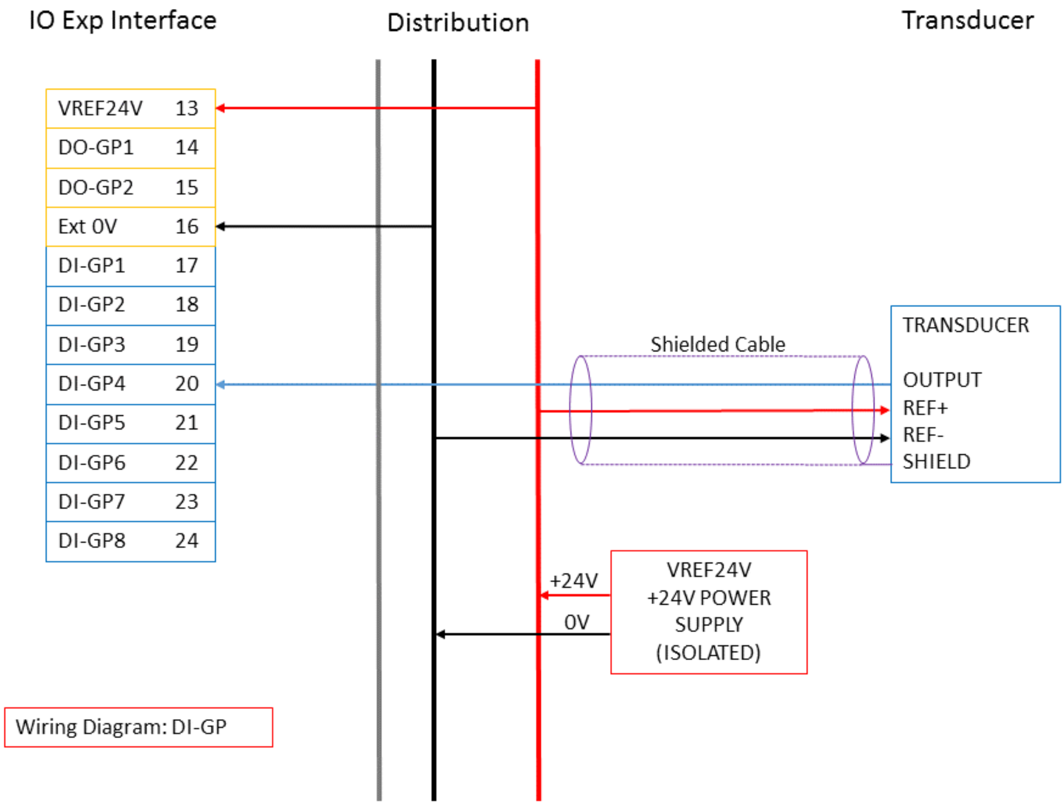


Figure 6-5: Typical Wiring Diagram: DI-GP

6.7.7 Analog Input

The Analog Input subsystem has two Differential Inputs which supports external Transducers with either a Differential or Single Ended output format.

A Transducer with a Single Ended Output format is formed by connecting the Output Signal to the appropriate channel input (P/N) and connecting the other channel input to the appropriate Reference (usually the Negative Reference).

A typical wiring diagram of the Analog Input subsystem is shown in *Figure 6-6: Typical Wiring Diagram: AI.*

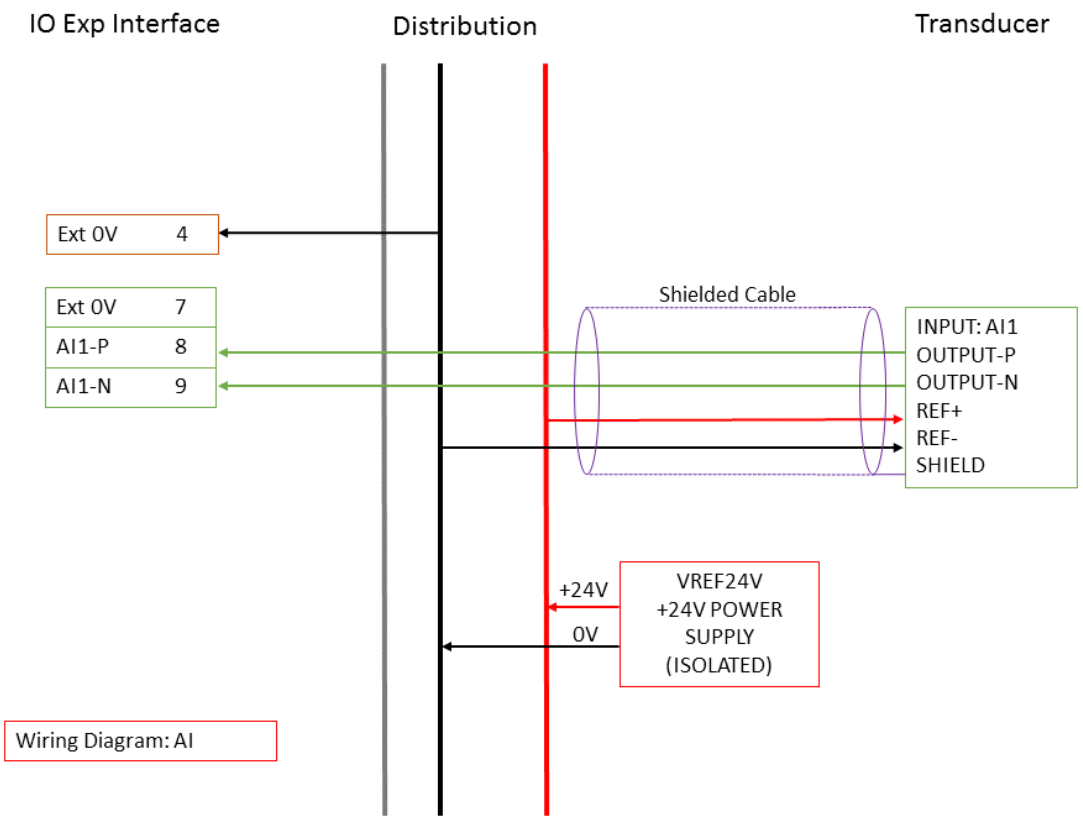


Figure 6-6: Typical Wiring Diagram: AI

6.7.8 Analog Output

The Analog Output subsystem has one Single Ended Output referenced to the common Negative Reference.

A Transducer with a Differential Input format could be interfaced to the Analog Output by connecting the Channel Output Signal to the appropriate Transducer Differential Input (P/N) and connecting the other Transducer Differential Input to the Negative Reference.

A typical wiring diagram of the Analog Output subsystem is shown in *Figure 6-7: Typical Wiring Diagram: AO.*

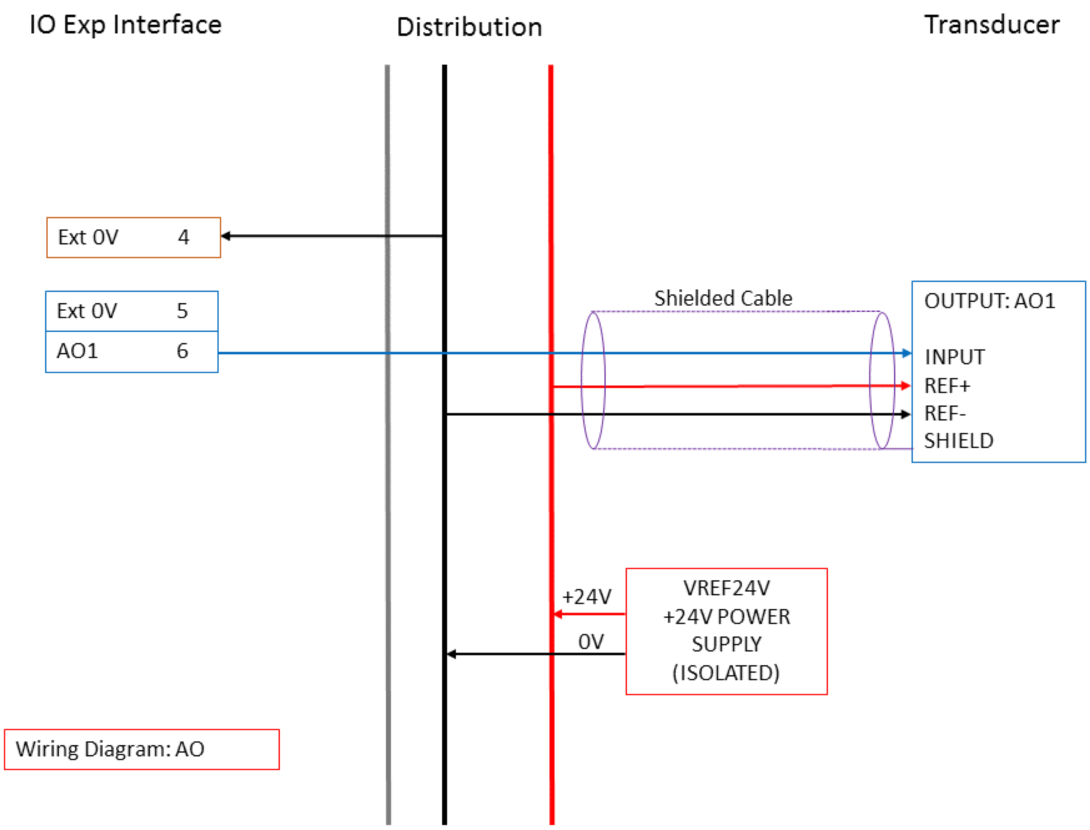


Figure 6-7: Typical Wiring Diagram: AO

7 EtherCAT® Configuration

7.1 Introduction

This chapter contains the EtherCAT LED Status Definitions for the AMD5x Drive and PIU.

This manual does not cover configuration of the Drive. Please refer to the Digital Servo Drive SoE Parameter Reference, please contact *Product, Sales and Service Enquiries*

The AMD5x PIU Frame Packet Mapping includes information on the Input and Output types. This chapter also describes the Boolean Inputs and Outputs, and Integer Inputs for when used with ANCA CNCs. When being used with other products, please contact *Product, Sales and Service Enquiries*

7.2 EtherCAT LED Status Definitions

As shown in *Figure 7-1* 4 LEDs are located on the AMD5x EtherCAT interface: RUN, L/A and ERROR. The LEDs are Green (RUN) & (L/A), and Red (ERROR) in color. The LED state and LED blink rates are detailed in *Table 29* , *Table 30* and *Table 29*

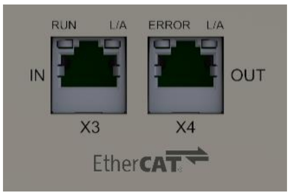


Figure 7-1: EtherCAT Indicators

7.2.1 EtherCAT RUN Indicator

The normal (working) state of the RUN LEDs is On.

Table 29: EtherCAT RUN LED Indicator states

State of LED	Description
On	The AMD5x is Operational
Flickering	The AMD5x is booting or downloading Firmware
Blinking	The AMD5x in the Pre-Op state
Single Flash	The AMD5x is in a Safe-Operational State
Off	The AMD5x is Off or is in an Initialisation State

7.2.2 EtherCAT Error Indicator

The normal (working) state of the ERROR LEDs is Off.

Table 30: EtherCAT ERROR LED Indicator states

State of LED	Description
On	A critical communication or application error has occurred
Flickering	A booting error had been detected
Blinking	A general configuration error has occurred
Single Flash	A local error has occurred
Off	No Error has occurred and communication of theAMD5x is in working order

7.2.3 EtherCAT L/A LED Indicators

The EtherCAT Link/Activity (L/A) LED for the IN and OUT Ports is located on the top right hand corner of the RJ-45 connector. The states of the L/A LED are detailed in the following table. The L/A LED is green in colour.

The normal (working) state of the L/A LED is flickering.

Table 31: EtherCAT Link/Activity LED Indicator Blink Rates

State of LED	Activity	EtherCAT Linked
On	No	Yes
Flickering	Yes	Yes
Single Flash	No	No
Off	N/A	No

7.2.4 EtherCAT LED Indicator Blink Rates

The blink rates EtherCAT RUN and ERROR LEDs ar shown in *Table 32.*

Table 32: EtherCAT Indicator Blink Rates for RUN and ERROR

State of LED	Frequency
On	Constantly On
Flickering	10Hz, On for 50ms and off for 50ms
Blinking	2.5Hz, On for 200ms and off for 200ms
Single Flash	On for 200ms and off for 1000ms
Off	Constantly Off

7.3 PIU Frame Packet Mapping

The EtherCAT Frame Packet consists of Table 33 to Table 35 described below. The 4 tables are consecutive in the frame packet, but the information is described in separate tables below for ease of reading.

7.3.1 Inputs – Status, Error and Warning

All EtherCAT Frame Packet Input states are 1 bit in size unless indicated. Single bit states are active with Bit Value=1. Any active Error bit will disable the PIU.

Table 33: EtherCAT Input Status, Error and Warning states.

LABEL	DESCRIPTION
Grid	Status: 3 phase mains is present
Charging	Status: DC Bus capacitor bank is charging.
BBR	Status: Reserved Data
Rgn	Status: Regen IGBT is turned on
RgnCnct	Status: Regen IGBT has been commanded to be turned on.
RgnTest	Status: Regen Brake Test is in progress.
Ready	Status: PIU has completed starting sequence with no errors and is ready to accept load.
Thyrist	Status: Hardware signal showing rectifier thyristors are being gated on.
E_24 V	Error: 24 Vdc control supply voltage measurement is <19V or >29V.
E_RgnIGBT	Error: REGEN IGBT has a short circuit load
E_RgnTemp	Error: X5 input from over-temperature switch mounted on REGEN resistor
E_GridSeq	Error: Phase rotation check of the mains 3 phase supply, after PIU is enabled
E_Current	Error: DC Bus current exceeds IDC+ in the + direction or IDC- in the – direction **
E_HiVolt	Error: DC Bus voltage is >900V.
E_LoVolt	Error: DC Bus voltage is <320V while PIU is in ‘Ready’ state.
E_ThyristTemp	Error: Rectifier thyristor module internal temperature > 110°C.
E_HeatsnkTemp	Error: Heatsink temperature >70°C.
E_Grid	Errror: mains 3 phase supply cannot be detected
E_GridFrq	Error: Mains frequency is out of range of 47Hz to 64Hz.
E_RgnTest	Error: Regen Resistor Test has failed.
E_I2t	Error: DC Bus Over current and time detection
W_Gnd	Warning: Drive phase to earth fault or mains corner earth connection.
W_LedOpen	Warning: iView Led driver connection is open circuit.
W_LedShort	Warning: iView Led driver connection is short circuit.
E_StrtVolt	Error: After the PIU is Enabled, the measured residual DC Bus volts is greater than 50V.
E_RsdlVolt	Error: The residual DC Bus volts is greater than 50V after 3s discharge period.
F_Config	Fault: Incorrect product configuration. Service required
R	Reserved
R	Reserved
R	Reserved
R	Reserved
W_Fan	Warning: Heatsink fan is either not connected or not rotating correctly.

**For the 15kW PIU IDC+ = 130A (Load current), and IDC- = -50A (Regen current).
For the 24kW PIU IDC+ = 240A (Load current), and IDC- = -100A (Regen current).

7.3.2 Inputs – Analogue Variables

The EtherCAT Frame Packet for analogue variables which can be monitored is shown in *Table 34*.

Table 34: Input Analogue variables.

LABEL	DESCRIPTION	UNIT	SIZE
R	Reserved	n/a	USINT8
Volt	DC Bus voltage	Volts	UINT16
Current	DC Bus current	x 0.1 Amp	INT16
Power	Calculated from product of DC Bus voltage and DC Bus current	x 10 Watt	INT16
R	Reserved	n/a	UINT16
AmbientTemp	Measured temperature of PIU controller PCBA. Range of -55°C to 125°C.	°C	INT16
ThyristTemp	Measured temperature of rectifier module internal sensor. Range of 2°C to 120°C	°C	USINT8
R	Reserved	n/a	USINT8
HeatsinkTemp	Measured temperature of heat-sink temperature sense. Range of 2°C to 120°C	°C	USINT8
R	Reserved	n/a	UINT8
24 V	Measurement of customer 24 Vdc supply. Range of 0V to 48.18V	x 0.1 Volts	UINT16
GridFrq	Calculated mains frequency to 2%.(±0.5Hz)	0.1 Hz	UINT16

7.3.3 Outputs

All EtherCAT Frame Packet Output Digital states are 1 bit in size, and active with Bit Value=1.

Table 35: Output Digital Variables. 8 bits total

LABEL	DESCRIPTION
Enable	Initiate PIU start up sequence and resets any existing fault condition.
RegTest	Request for Regen Brake Test.
R	Reserved
R	Reserved
R	Reserved
R	Reserved
R	Reserved
R	Reserved

Table 36: Output Analogue variables.

LABEL	DESCRIPTION	UNIT	SIZE
LED_Intensity	1 byte to set LED_intensity (*9.6 LED Supply*). Lower values means dimmer light. 0 equals no light, 255 equals full brightness.	n/a	8 bits
R		n/a	8 bits

8 Installation Checklist

8.1 What this Chapter Contains

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

8.2 Checklist

- ❐ The installation location satisfies the requirements in *10.5.3 Installation and Operation.*
- ❐ An adequately sized protective earth connector is installed between the PIU and the installation Earth Bar.
- ❐ The required ventilation clearances around the drive have been observed per section *4 Mechanical Installation*.
- ❐ An adequately sized protective earth conductor is installed between each drive and motor.
- ❐ Each protective earth conductor is connected to the appropriate terminal and is secured.
- ❐ Each internal protective earth and DC Bus conductor is connected to the appropriate terminal and is secured.
- ❐ The control supply voltage is within the limits of operation of the drive. See *10.4.1 AMD5x PIU*
- ❐ The input power cable is correctly sized and securely connected to the X2 plug. See *5.2 Mains Power Supply*
- ❐ Appropriate supply fuses and disconnect devices have been installed. See *5.2 Mains Power Supply*
- ❐ An appropriate inductor must be installed between the AMD5x PIU input (X2) and 3 phase mains AC supply. See *5.5 Installations Conforming to the EMC Directive* for recommended inductor ratigns and installation.
- ❐ The motor cable is connected to the appropriate terminals, the phase order is correct and the conductors are secured.
- ❐ The brake resistor cable has been connected to the appropriate terminals and the connections are secure (see *5.9 Regeneration*)
- ❐ The motor cable and brake resistor cable (if applicable) have been routed away from other cables.
- ❐ The motor cable Hiperface DSL segment is connected to the appropriate Hiperface DSL Interface Drive connector
- ❐ The motor cable Hiperface DSL segment shield is located squarely within the Hiperface DSL EMC Clamp, and the Clamp is securely fitted to the Gear Tray
- ❐ The motor cable armature segment shield is located squarely within the Armature EMC Clamp, and the Clamp is securely fitted to the Gear Tray
- ❐ The Hiperface DSL conductors are secured and appropriate strain relief has been

implemented

- ❐ Excess lengths of Hiperface DSL motor cables are not coiled
- ❐ Hiperface DSL motor cables are separated from each other
- ❐ No power factor compensation capacitors have been connected to the motor cable.
- ❐ A sinusoidal filter has been installed in between the motor armature output on the drive and the motor if required by the application.
- ❐ All low voltage control cables have been correctly connected and are secure.
- ❐ External References required by the Drive IO Interface have been correctly connected and are secure.
- ❐ There is no dust or other foreign object inside the drive after installation (e.g. Due to cutting of cables etc.).
- ❐ All wiring conforms to applicable regulations and standards.
- ❐ Insulation of power wiring has been tested. See *5.11 Checking the Insulation of the Assembly.*
- ❐ No physical damage is present to any component within the system.
- ❐ The drive and all equipment connected to the motor is ready for start-up.
- ❐ A risk assessment has been completed on entire machine and is considered by the user to be safe for operation.
- ❐ Regeneration energy and power has been assessed and external resistor has been connected (see *5.9 Regeneration*)
- ❐ There are no shorts between encoder power supplies and encoder GND.
- ❐ The mains supply voltage is within the limits of operation of the drive. See *10.4.1 AMD5x PIU*

9 PIU Operation

9.1 What this Chapter Contains

This chapter contains information related to typical operating conditions of the PIU and expected data for these conditions

9.2 PIU Introduction

The Passive Infeed Unit (PIU) provides power to all the Drives by converting 3 phase mains to a filtered DC supply which is distributed to the servo drives on common bus. The PIU uses a half controlled bridge rectifier to slowly charge the DC Bus capacitors in the PIU and Drives. Once the capacitors are charged, the DC output voltage varies according to the supply mains voltage and load power.
The PIU also distributes the customer supplied 24 Vdc control voltage to all drives, provides a LED power supply, and interfaces via EtherCAT.

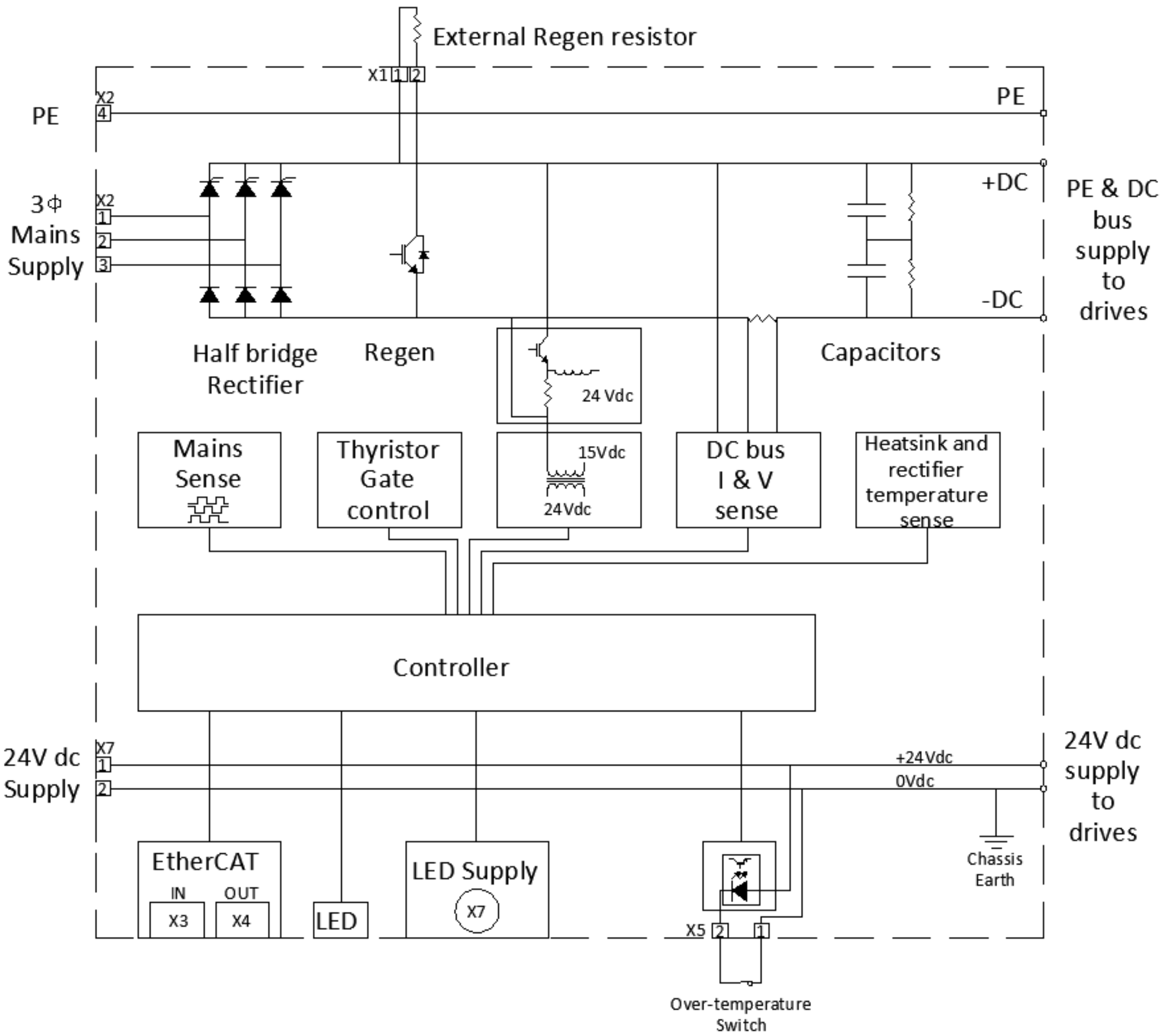


Figure 9-1: Block diagram of the PIU system

9.3 PIU not Enabled

When the PIU is not Enabled, the thyristors in the half bridge (see *Figure 9-1: Block diagram of the PIU system)* will be turned off and not allow charging of the DC Bus. The thyristors control power flow to the DC Bus but do not provide electrical isolation from the mains supply. The Regenerative Brake Resistor will be turned on if the PIU is not enabled.

When the PIU is not Enabled no errors (see *Table 33*) will be latched. The 8 bits which represent hardware states (see *Table 33*) will be operational.

The start and stopping of the PIU is controlled by the EtherCAT output variable **Enable** (*Table 35*). After 24 Vdc power is applied to the PIU and Drives, the PIU will not be Enabled and no errors (see *Table 33*) will be latched. The 8 bits which represent hardware states (see *Table 33*) will be operational. When the PIU is not Enabled, the thyristors in the half bridge (see *Figure 9-1*) will be turned off and not allow charging of the DC Bus. The thyristors control power flow to the DC Bus but do not provide electrical isolation from the mains supply.

9.4 Enabling the PIU

The main function of the PIU when Enabled is to charge the DC Bus capacitors in the PIU and drives, and then provide continuous power to connected drives. The PIU should be Enabled at least 1s after three phase mains contactors are closed. The start-up sequence can be broken up into 4 key areas: Mains Check, Capacitor Charging, Regenerative Brake Resistor test, and Load Application.

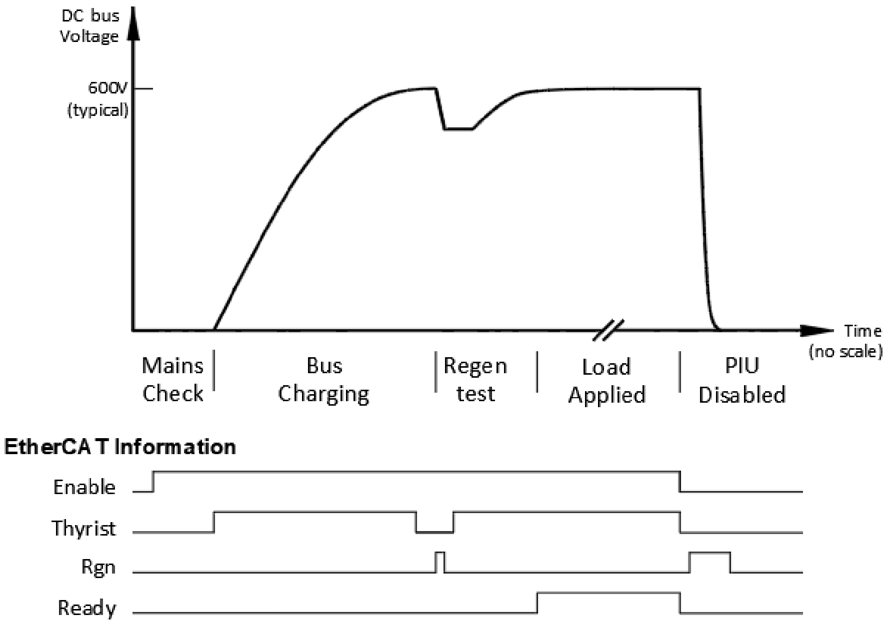


Figure 9-2: Timing graph of typical DC Bus voltage and status bits after enabling the PIU

9.4.1 Mains Check

After an Enable command is received the PIU checks the 3 phase mains is present and automatically determines the correct phase rotation to control the thyristors. The mains check typically takes 3 to 4 seconds after being enabled.
The status bit **Grid**=1 indicates the mains is present and the PIU can be enabled.

If the mains check fails the status bit **E_GridSeq** =1 or **E_Grid**=1 will be set. This denotes the measured mains frequency is out of 47-64Hz range or the status bit **Grid**=0. Typically this error is due to loss of one phase or more, or the mains has significant distortion. If the warning **W_Gnd**=1 is set after being enabled then the charging sequence will be stopped. This indicates an incorrect grounding configuration. Refer *5.2.3 Connection of PIU to non-grounded (IT) or Delta systems.*

At the end of the mains check the DC Bus voltage is measured and if it is greater than 50V the status bit **E_StrtVolt**=1 will be set, the charging sequence will be stopped, and the Regenerative Brake Resistor will turned on for up to 6s.

9.4.2 Capacitor Charging

Once the mains is determined to be present and DC Bus volts is below 50V, the thyristors are turned on and slowly ramp up the DC Bus voltage. The slow voltage rise limits the charging current to the capacitors in the Drives and PIU. This stage typically takes 1.5s . The status bits **Charging**=1 and **Thyrist**=1 are set during this period.

If there is a problem charging the DC Bus the following alarms may be generated:

- **E_Current** =1 when the peak charge current is greater than 130A. Note that mains supply circuit breakers may also trip if this occurs. This is normally due to a short circuit on the bus, which may be in the PIU or drives, or the regen resistor may have a short to ground, or severe drive current overload.
- **E_LoVolt** =1 when the bus voltage is not greater than 320V after the capacitor charging stage.

9.4.3 Regenerative Brake Resistor Test

The regen resistor test is applied every time the PIU is enabled and after the capacitor charging is complete. The test may also be performed while the PIU is Ready by setting the EtherCAT output variable **RegTest**=1. The **RegTest** is edge triggered and ignored if PIU does not indicate a Ready status. The drive load must be disabled during the regen resistor test.

Once the DC Bus is charged the thyristors are briefly turned off (**Thyrist**=0) and the customer Regenerative Brake Resistor is checked by applying a 5ms ON pulse to the Regenerative circuit. The PIU measures the Regenerative Brake Resistor current which must be within acceptable limits for the test to pass. Acceptable limits will be achieved with a functional Regen Resistor which meets the resistance requirements which depend on the PIU rating. Refer *5.9.1Regenerative Brake Resistor* for acceptable resistance values.

Note that measured Current value will be negative because the current flow is opposite to the normal Load current. The DC Bus voltage will drop slightly during the test. The status bit **Rgn**=1 is briefly set for 5ms during the test. If the test is passed, the thyristors will be turned on, and the DC Bus will recover to normal operating values.

If the regen resistor test fails the error bit **E_RgnTest**=1 will remain set and the DC Bus will be fully discharged unless there is a IGBT error **E_RgnIGBT=1**. This error **E_RgnIGBT** fault indicates a severe overcurrent in the regen IGBT and is likely due to a short or grounded connection in the external regen resistor circuit. If the status bit **E_RgnIGBT**=1 during the regen test, then the test will be stopped and the regen IGBT disabled.

DANGER HIGH VOLTAGE - The DC Bus may not be discharged after the above test. The Main Isolator feeding the PIU must be switched to the **Off** position at least 15 minutes before any work is commenced on the unit. The operator must check the DC Bus is discharged and isolated from mains supply with a tested working voltage measuring instrument prior to disconnecting any connectors or exposing any part of the DC Bus.

During the regen test the thyristors are briefly turned off and the discharge energy is supplied by the bus capacitors. Thus the bus capacitance is also tested and faulty capacitors may result in a failed test.

9.4.4 Load Applied

After the Regen resistor test is complete and the thyristors are fully turned on (**Thyrist**=1), the PIU is ready to accept load and this is indicated by the status bit **Ready**=1. Typically the PIU will be ready approximately 7s after being enabled, with a maximum time of 10s.The drives can now be operated. The DC Bus voltage is unregulated and may fluctuate according to the power utilised by the drives.

If load is applied during the Regenerative Brake Resistor test or capacitor charging stage, the test may fail or the error **E_LoVolt** =1 may occur.

During operation of applied load regeneration may occur when DC Bus rises above 806V , and the status bit **Rgn**=1 will be set. Refer *5.9 Regeneration*.

9.4.5 Disabling the PIU

In normal operation (no PIU faults), after the PIU has been Disabled the thyristors are turned off (**Thyrist**=0) and the Regen Resistor will be turned ON (**Rgn**=1) for 3 seconds only to discharge the DC Bus voltage. If the PIU is Enabled again during the 3s discharge period, then PIU normal starting sequence will be delayed until the end of the 3s discharge period. If the DC Bus volts is greater than 50V after the 3s discharge period, then the fault bit **E_RsdlVolt**=1 will be set and the Regen Resistor will continue to be turned on for up a further 6s in an attempt to discharge the DC Bus.

.

9.5 Monitoring the PIU

The EtherCAT interface to the PIU provides simple access to error status and analogue information, which can assist system monitoring and fault finding. The start-up sequence shown in *Figure 9-2: Timing graph of typical DC Bus voltage and status bits after enabling the PIU* can be replicated in normal operation by simply monitoring appropriate variables.

9.5.1 DC Bus Measurements

The main function of the PIU is to generate DC Bus power, thus the DC Bus Voltage should be the primary analogue measurement to be monitored during startup and load application.
The DC Bus Current & Power measurements show how much load is being supplied by the PIU. These two measurements are filtered to remove mains ripple, and a negative value indicates power is being dumped to the Regenerative Brake Resistor, while a positive value indicates power is being supplied to the Drives.

9.5.2 Temperature Measurements

Heat generated by the PIU rectifier is removed by the heatsink which is cooled by air flow in the external cooling duct. The heatsink temperature sensor is a slowly changing value dependant on PIU load, cooling air temperature and flow rate. The sensor has a measuring range of 2°C to 120°C, with trip point of 70°C where error **E_HeatsnkTemp** =1 is set. If this error occurs the user should check cooling fans, load, and heatsink fins for contaminants such as dust.
The rectifier module temperature sensor is located internally to the rectifier. This sensor reads a higher value than the heatsink temperature, and has faster response to load increases. The sensor has a measuring range of 2°C to 120°C, with error trip point of 115°C where error **E_ThyristTemp**=1 is set.
The ambient temperature sensor is located on the controller PCB.

The wall and recessed PIU variants monitor the heatsink fan and will generate an EtherCAT warning **W_Fan**=1 if the fan is not connected, or Fan is not rotating correctly. This will not stop the PIU.

9.5.3 Control Supply Voltage

This is a measurement of customer 24 Vdc supply with a range of 0V to 48.18V. An error is generated when the voltage is less than 19V and greater than 29V, and the error **E_24 V**=1 is set. When the control voltage drops below 19V, the AMD5x Drive(s) will shut down.

9.5.4 Grid Frequency

Measurement of customer mains frequency begins after the PIU has been enabled. The calculated measurement has an accuracy of 2% (±0.5Hz) and a measuring range of 47Hz to 64Hz. If the measurement is out of range, the error **E_GridFrq**=1 is set. This error may occur after a mains failure.

9.5.5 Fault Detection Bits

The 16 EtherCAT status errors are listed in *Table 37*. When an error occurs only the first detected error is latched even if other faults occur for the same event.
For Errors 1 to 13, & 17: The thyristors are immediately disabled. (**Thyrist**=0). All errors except Regen IGBT Fault will result in the DC Bus being discharged immediately. The errors can be cleared by the next 'Enable' command transition from '0' to '1'.
For Errors 14 to 16: The PIU will continue to operate.

Table 37: PIU Input Fault states and actions

LABEL	DESCRIPTION	Action
1. E_24 V	The 24 Vdc control supply voltage connected to X7 is less than 19V or greater than 29V.	Check 24 Vdc supply before next PIU Enable
2. E_RgnIGBT	Internal Regen IGBT has detected a short circuit load during Regen Brake Resistor operation.	Check Regen Brake Resistor and wiring circuit.
3. E_RgnTemp	Over-temperature switch mounted on the Regen Brake Resistor connected to X5 is open.	Check Regen Brake Resistor for over-heating and check switch circuit before next PIU Enable
4. E_GridSeq	Phase rotation of mains 3 phase supply cannot be determined after the PIU is Enabled.	Check all phases are present before next PIU Enable
5. E_Current	DC Bus peak current is greater than: 130A or below -50A (Regen) for 15kW PIU 240A or below -100A (Regen) for 24kW PIU	Check Regen Brake Resistor circuit, and check Drives are not overloaded.
6. E_HiVolt	The DC Bus voltage is greater than 900V due to excessive drive regeneration.	Check Regen Brake Resistor is sized and functioning correctly.
7. E_LoVolt	The DC Bus voltage is less than 320V while the PIU is ready. (**Ready**=1)	Customer to check all phase are present and above minimum requiements, and check drives are not overloaded.
8. E_ThyristTemp	Rectifier module internal temperature is greater than 110°C.	Check heatsink cooling and fan system.
9. E_HeatsnkTemp	Heatsink temperature is greater than 70°C.	Check heatsink cooling and fan system.
10. E_Grid	Monitors Grid Present status. Check is made after PIU is enabled.	Check all phases are present before next PIU Enable.
11. E_GridFrq	Frequency of either of the three phase mains suppy is out of range 47Hz to 64Hz. Check is constantly made after PIU is Enabled.	Check all phases are present and stable, and above minimum requiements.
12. E_RgnTest	Regen Brake Resistor Test has failed.	Check Regen Brake Resistor, bus capacitors.
13. E_I2t	DC Bus current has exceeded 31A (for 15kW PIU) or 50A (for 24kW PIU) for an extended time.	Reduce continuous or overload operating current.
14. W_Gnd	AC voltage between DC Bus and customer Protective Earth is too large.	Customer 3-phase mains is corner earth connection. AMD5x Drive has phase to PE short circuit which does not trip drive overcurrent.
15. W_LedOpen	The LED driver has detected no LEDs connected. Test performed when LED intensity command moves from 0 value.	Check LEDs and wiring circuit connected to PIU connector X6

16. W_LedShort	The LED driver has detected a short circuit. Test performed when LED intensity command moves from 0 value.	Check LEDs and wiring circuit connected to PIU connector X6
17. E_StrtVolt	After the PIU is Enabled, the measured DC Bus volts is greater than 50V before commencing capacitor charging. The PIU will be stopped.	Check Regen Resistor, Ground Flt status bit, and contact service.
18. E_RsdlVolt	The residual DC Bus volts is greater than 50V after 3s discharge period.	Check Regen Resistor, Ground Flt status bit, and contact service.
19. W_Fan	Heatsink fan is either not connected or not rotating correctly	Check fan is connected, fan blades are not blocked, fan bearings are not seized.

9.6 LED Supply

The AMD5x PIU has an additional LED driver feature where the brightness to a customer string of 6 LEDs can be controlled via EtherCAT Output Analogue variable **LED_Intensity**. The LEDs are connected to X6. Refer *3.6.4 X6 – LED Supply*. The 6 LEDs to be used are ANCA part number: ICN-3097-0058. The EtherCAT intensity command setting has a range of 0 to 255, where 0 equals no light (0mA output), and 255 equals full brightness (20mA output). The LED supply is current controlled with a range of 0 to 20mA. The LED output is isolated with a transformer from the controller 24vdc supply and connected to the chassis earth with a high impedance connection. Thus if either LED output is accidently shorted to ground the LED driver will continue to function normally. The LED output is also protected from open and short circuits.

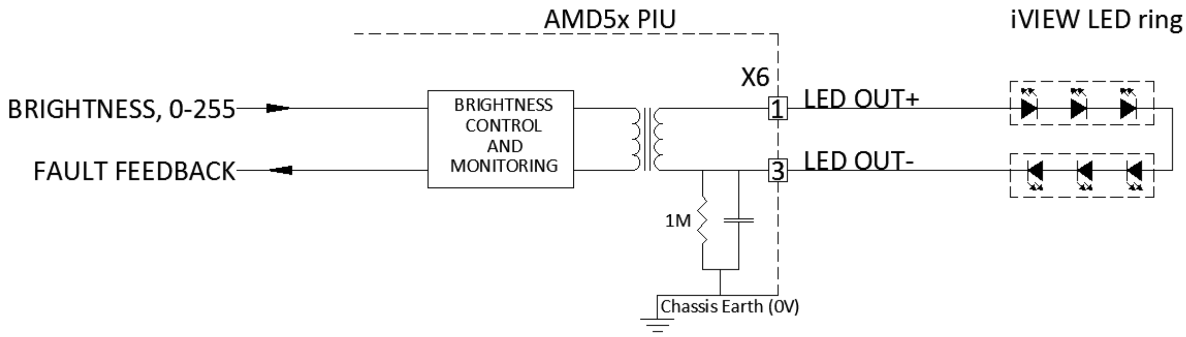


Figure 9-3: LED Supply

9.6.1 LED Fault Detection

The LED driver has a diagnostic tool to determine if the iView LED ring circuit is open or short circuit. The diagnostic test is implemented every time the brightness is increased from zero to any other setting. After a brightness command is increased from zero, a brief pulse of current at approximately 50% brightness is applied to the circuit to determine normal, open circuit, or short circuit operation. This brief pulse will be visible for approximately 0.2s. If normal operation is detected, the LED brightness will be set to the user commanded value. If an open or short circuit is detected, the EtherCAT warnings **W_LedOpen** or **W_LedShort** will be set, and the LED brightness will be set to the user commanded value to assist debugging.

The EtherCAT warnings **W_LedOpen** or **W_LedShort** will not be activated if an open or short circuit is applied after the brightness has been set to a non-zero value.

Note: When either the W_LedOpen or W_LedShort LED is set, the PIU will not be disabled and will continue to operate normally. Refer *Table 37 .*

10 Technical Data

10.1 What this Chapter Contains

This chapter contains information related to detailed specifications of the Drive and PIU:

- Control Functions
- Interface Specifications
- Electrical Specifications
- Performance Specifications
- Environmental Specifications
- Mechanical Dimensions and details
- Standards Compliance

10.2 Control Functions

Table 38: Control Functions

Attribute	***Qualification***
10.2.1 Control Modes	
Linear Control	Yes
Rotational Control	Yes
Position Control	Via EtherCAT (SoE)
Velocity Control	Via EtherCAT (SoE)
Current/Torque Control	Via EtherCAT (SoE)
Sinusoidal Permanent Magnet Servo Control	Yes
Sinusoidal Induction Motor Control	Yes
10.2.2 Thermal and Over-Current Protection	
3A, 6A, 12A Drive amplifier temperature limit	80° C
20A Drive heat-sink temperature limit	80° C
35A and 35AH Drive amplifier temperature limit	110° C
PIU heat-sink temperature limit	70° C
Drive Adjustable dynamic current limiting	Yes
Drive Adjustable continuous over-current monitoring	Yes
Drive Adjustable instantaneous over-current monitoring	Yes
Drive amplifier junction temperature estimation and protection for motor low rotation frequency and standstill operation	Yes

Attribute	***Qualification***
10.2.3 Self-Protection Features	
PIU DC Bus overcurrent	Yes
PIU DC Bus over and under voltage	Yes
Motor overload	Yes, see AMD5x Series Servo Drive –SoE Configuration Guides for adjustment.
Over-travel limit exceeded	Yes
10.2.4 DC Bus Voltage Control	
Bus voltage monitor	Yes
Bus regeneration brake chopper	Yes
Bus over/under voltage adjustable limits	Yes
10.2.5 Advanced Control Functions	
DC Bus compensation	Yes
Backlash compensation	Yes
Probing	Yes
Pre-defined Drive Controlled Moves (DCM)	Yes – up to 64 move segments
Drive Controlled Homing (DCH)	Yes
Field Orientation Modes	• DQ Alignment • Preconfigured Offset • Acceleration Observer • Absolute
EtherCAT Slave Mode	Yes
Stand-alone Mode	Yes
Field Firmware Updates	Yes
Position Latch	Yes
Persistent Configuration Data	Yes (via EEPROM)
Continuous ADC Calibration	Yes

10.3 Interface Specifications

Table 39: Interface Specifications

Attribute	Qualification
10.3.1 Motor Position Feedback	
Number of position feedback channels	Total: three Ch1: Analogue 1 Vpp Ch2: Analogue 1 Vpp Hiperface DSL or BiSS or ABZ
Supported Encoders	Analogue Incremental Sin/Cos (1 Vpp) Hiperface DSL (20/23 bit), BiSS or ABZ
10.3.2 Encoder Channel 1	
Interface Type	Analogue 1 Vpp
Supported Inputs	Sin, Cos, Ref (1 Vpp)
1 Vpp Commutation Track	Supported
1 Vpp Terminating Resistance	120 Ω for Incremental and Reference, 1kΩ for Comm Tracks
1 Vpp Full Scale Differential Input Voltage	1.5 Vpp
Acceptable range of DC Offset Voltage	1.0V to 3.0V DC
1 Vpp Bandwidth	600 kHz for Incremental, 22kHz for Comm Tracks
10.3.3 Encoder Channel 2	
Interface Type	Analogue 1 Vpp
Supported Inputs	Sin, Cos, Ref (1 Vpp)
1 Vpp Commutation Track	Not supported on Channel 2
1 Vpp Terminating Resistance	120 Ω for Incremental and Reference
1 Vpp Full Scale Differential Input Voltage	1.5 Vpp
Acceptable range of DC Offset Voltage	1.0V to 3.0V DC
1 Vpp Bandwidth	600 kHz for Incremental
10.3.4 Encoder Supplies for Ch1 and Ch2 and BiSS/ABZ	
Supply Voltage (Nominal)	5.19V DC, regulated
Supply Voltage Range	5.10V DC to 5.25V DC
Supply Voltage Monitoring	Yes
Maximum Supply Current per Channel	500mA
Maximum Supply Current total, both Channels	500mA
Short Circuit Protection	Yes, 950mA maximum (internally limited)

Attribute	***Qualification***
10.3.5 Hiperface DSL Encoder	
Number of Hiperface DSL Channels per AMD5x Drive	One
Encoder Cable Format	Two wire (integrated data and power signals)
Signal Bandwidth	9.375 Mbps
Hiperface DSL Power Supply Level	7 Vdc ≤ Vsupply ≤ 12 Vdc at 250 mA at the Hiperface DSL encoder interface
Motor Temperature Feedback	Supported via encoder IO channel
Encoder Type	SICK EKx36 (18~20 bit) & EFx50 family (21~23 bit) single-turn and multi-turn
10.3.6 BiSS/ABZ Encoder	
Number of BiSS/ABZ Channels per AMD5x Drive	One
BiSS Encoder Cable Format	3 Pairs (Master & Slave data, & power pair)
ABZ Encoder Cable Format	4 Pairs (A, B & Z data, & power pair)
BiSS Signal Bandwidth	20 Mbps
ABZ Signal Bandwidth	1 MHz (4M counts/sec)
Data Physical Interface	RS-422 120Ω termination resistance
10.3.7 Ethernet Interface	
Protocol	EtherCAT
Baud Rate	100 Mb/s
Drive Profile Definition	SoE
Connector	Ethernet RJ-45
10.3.8 Drive Display	
Indicator	Bi-Colour Red/Blue LED

Attribute	Qualification
10.3.9 IO Interface	
10.3.9.1 Digital Input	
Number of Inputs	Eight
Configuration	single ended
Nominal DC Input Voltage	+24 Vdc
Maximum DC Input Voltage	+28.8 Vdc
Minimum Must Detect Input Voltage	+11 Vdc
Maximum Must Not Detect Input Voltage	+5 Vdc
DC Input Current per Input	5 mA max.
Detection Bandwidth	DC to 500 Hz
Isolation	Provided
10.3.9.2 Digital Output – General Purpose	
Number of Outputs	Two
Configuration	single ended
Output Voltage (nominal)	+24 Vdc
Reference Voltage (nominal)	+24 Vdc (User supplied)
Reference Voltage Range	+20.4 to +28.8 Vdc (User supplied)
Output Current (maximum)	500 mA @ 24 Vdc
Multiple Output State Configuration	Multiple digital outputs can be turned ON Total output load current across all outputs ≤ 500 mA
Output Architecture	Push Pull
Load Type	Resistive and inductive
Switching Bandwidth	DC to 1 kHz
Short Circuit Protection	Provided
Isolation	Provided
10.3.9.3 Digital Output – High Speed	
Number of Outputs	Two
Configuration	single ended
Output Voltage Range	+5 to +24 Vdc
Reference Voltage Range	+5 to +24 Vdc (User supplied)
Output Current (maximum)	500 mA at +24 Vdc per digital output
Multiple Output State Configuration	Multiple digital outputs can be turned ON concurrently
Output Architecture	Push Pull
Load Type	Resistive
Output Setting: Enable Control	Enable control per output: Normal (Active), high impedance

Attribute	*Qualification*
Switching Frequency Range	DC to 20 kHz
PWM Output Mode: Switching Frequency Range	1 Hz to 5 kHz
PWM Output Mode: Pulse Width	0.2 to 20 mS
PWM Output Mode: Pulse Width: Resolution	50 µS
PWM Output Mode: Duty Cycle Range	0.02 to 100% (determined by switching freq. and allowable pulse width)
Short Circuit Protection	Provided
Isolation	Provided

10.3.9.4 Analog Input

Number of Inputs	Two
Configuration	Voltage, differential
Input Voltage Range (nominal)	-10 to +10 Vdc
Input Voltage (maximum)	±11.3 Vdc
Common Mode Range (combined common mode level and input signal level)	-10 to +10 Vdc
Resolution	12 bit
Measurement Accuracy	± 0.1% of full-scale at 25 °C ± 0.3% of full-scale over -20 °C to +65 °C
Frequency Bandwidth	DC to 1 kHz
Input Impedance (nominal)	20 kΩ
Short Circuit Protection	Provided
Isolation	Provided

10.3.9.5 Analog Output

Number of Outputs	One
Configuration	Voltage, single ended
Output Voltage Range (nominal)	-10 to +10 Vdc
Output Voltage (maximum)	±10.5 Vdc
Output Current (maximum)	10 mA @ 10 Vdc
Output Settling Time (input step 25% to 75% fullscale)	≤ 50 µs
Resolution	12 bit
Measurement Accuracy	± 0.1% of full-scale at 25 °C ± 0.3% of full-scale over -20 °C to +65 °C
Load Type	Resistive only
Short Circuit Protection	Provided
Isolation	Provided

10.4 Electrical Specifications

Table 40: Electrical Specifications

10.4.1 AMD5x PIUs

Attribute	Symbol	15kW PIU	24kW PIU
3 Phase Input Voltage	$U_{LL\text{-}(3\ \Phi)}$	380 to 480 VAC	
3 Phase Mains Voltage Fluctuation	U_{δ}	± 10%	
3 Phase Input Frequency	f_{LN}	47 to 63 Hz	
3 Phase Input Voltage Unbalance	$U_{LLb\text{-}(3\ \Phi)}$	3% (negative / positive phase sequence) Relevant standard: IEC 61000-2-4	
Input Frequency Slew Rate	f_{δ}	2 Hz/s	
Maximum Input Voltage to Protective Earth	$U_{L1,L2,L3\ \text{-}PE}$	300 VAC	
Overvoltage Category	U_{OV}	III	
Maximum Supply Prospective Fault Current	I_{SC}	25 kA	
Rated Continuous AC Input Current	I_a	26 A	35 A
Intermittent Input Current for 15s	I_{a1}	36 A	66 A
Intermittent Input Current for 5s	I_{a2}	50 A	98 A
Maximum Fuse I^2t Rating	I^2t	5000 A^2s	7200 A^2s
DC Output Voltage	U_{DC}	500 to 850 V	
Cont. Nominal DC Output Power* (@ U_{DC})	P_{DC}	15 kW (@ 500V)	24 kW (@ 600V)
Cont. DC Output Current	I_{DC}	30 A (100%)	40 A (100%)
Intermittent DC Output Current for 15s	I_{DC1}	43 A (143%)	80 A (200%)
Intermittent DC Output Current for 5s	I_{DC2}	60 A (200%)	120 A (300%)
Intermittent DC Output Current for 100ms	I_{DC3}	100 A (333%)	170 A (425%)
Continuous Regen Power	P_{RG}	10 kW	15 kW
Max Peak Regen Power (1s pulse)	P_{RG1}	36 kW (18R)	72 kW (9R)
24 Vdc Control Input Voltage	U_C	20.4 to 28.8 V	
24 Vdc Control Input Current	I_C	0.5 to 10.0A	
LED Driver output voltage[2]	U_{LD}	10 to 19 V	
LED driver output current	I_{LD}	0 to 20 mA	
DC Bus capacitance	C	705 µF	

*The DC output power of the PIU is dependent on the DC Bus voltage, which is in turn dependent on the Input supply voltage and the DC output current at that moment. The PIUs have been rated in terms of DC output currents under both continuous and intermittent loading conditions, since their design capability is essentially current-based. Converting these current figures to power requires determination of DC Bus voltage under continuous and intermittent conditions.

[2] LED driver specification for load of 6 LEDs . see 9.6 LED Supply

10.4.2 Drives

Attribute	Symbol	Qualification					
Current Rating		3A	6A	12A	20A	35A	35AH
DC Voltage	U_{DC}	600V Nominal, 500 to 850V range					
Max. Line to Line rms output voltage	$U_{LL\text{-}(3\,\Phi)}$	370V AC @ 600V DC Bus Input					
Continuous rms output current	I_{aN}	3 A	6 A	12 A	20 A	35 A	35 A
One-minute rms overload capability	I_{aM}	3.3 A	6.6 A	13.2A	22 A	38.5 A	38.5 A
Current I_q for ADC FSD	I_{qfsd}	12.3 A	24.5 A	36.8A	60 A	120 A	184 A
Current I_q for overcurrent trip	I_{qtrip}	12.0 A	24.0 A	36.0A	58.8 A	117.6 A	180.3 A
Maximum I_q current demand	I_{qmax}	9.2 A	18.5 A	27.7A	45.2 A	90.5 A	138.7 A
Intermittent rms repetitive overload current[3]	I_p	6.5 A	13.1 A	19.6A	32 A	64 A	98 A
Wall and Recessed mounted drives derating factor. Refer *10.4.4 Temperature Derating*		2% of I_{aN} / ºC, for 40 ºC < ambient temperature < 50 ºC					
Max. Peak repetitive overload duration	t_p	1 sec					
Min. Peak repetitive overload interval	t_s	10 sec					
PWM Switching frequency	f_s	8 kHz					
Current loop update rate	t_i	62.5 µs					
Drive efficiency @ Unity PF, 600VDC	η_D	97.1%	97.7%	98.1%	98.3%	98.5%	98.5%
Nominal output power rating[4]		1.9 kVA	3.9 kVA	7.7 kVA	12.8 kVA	22.5 kVA	22.5 kVA
Max. Output frequency at nominal $U_{LL\text{-}(3\,\Phi)}$	f_{max}	500 Hz					
DC Bus capacitance	C	135 µF	135 µF	135 µF	135 µF	270 µF	270 µF

10.4.3 Capacitor Module

Attribute	Symbol		Qualification
DC Voltage	U_{DC}		600 V Nominal, 500 to 850 V range
DC Bus Capacitance	C		2115 µF

[3] The Intermittent rms repetitive overload current Ip is determined by the maximum current demand Iqmax that can be asked for. This maximum current demand incorporates a control margin to ensure that the overcurrent trip is not triggered during normal intermittent operation.

[4] For a Permanent Magnet Servo Motor, the Power factor can be considered Unity, and therefore the kW output is the same as the kVA rating given here. For Induction Motors, since the PF will be less than one, the Output power will be less in kW as compared to the kVA rating given here.

10.4.4 Temperature Derating

To ensure maximum drive performance life and operation within component thermal limits, the continuous rms output current I_{aN} of Wall and Recessed mount drives must be derated when operating above 40ºC. The derating factor is 2% of I_{aN} / ºC, up to the maximum operating ambient temperature of 50ºC as shown in *Figure 10-1*. See also *10.4.2 Drive* for drive continuous rms output current ratings (I_{aN}). The Duct mount drives are specified for full load over 0ºC to 55ºC.

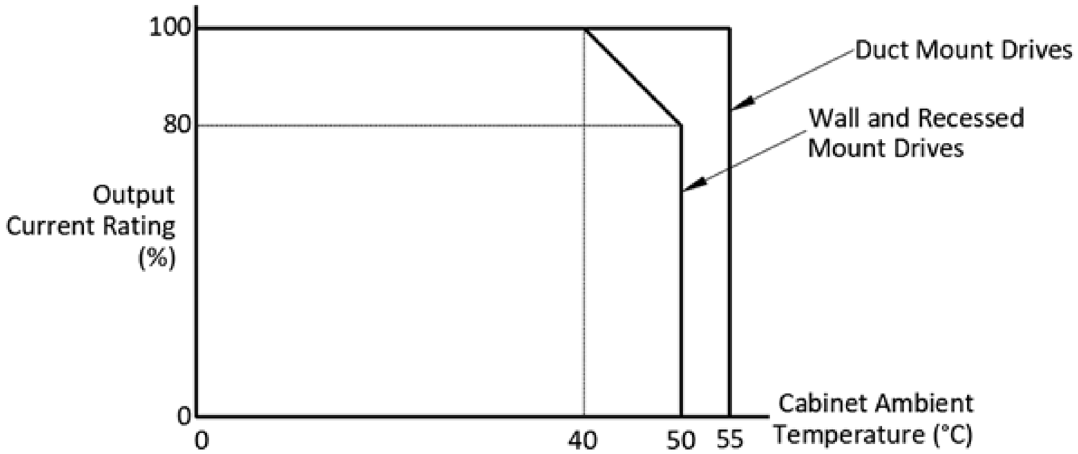


Figure 10-1: Drive continuous rms output current derating

The air inlet temperature to the heatsink of the duct mounted drives is limited to 0ºC to 45ºC to enable the full load current to be delivered.

10.5 Environmental Specifications

Table 41: Environmental Specifications

Attribute	***Qualification***
10.5.1 Storage	
Ambient Temperature	-20 to +65° C
Relative Humidity	5 to 90%
Storage dust and solid particles exposure limit	IEC 60664-1 Clean air pollution degree 2
Within the specifications given above, also do NOT allow the packaged PIU or Drive (in box) to exceed the following conditions as per 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	10 to 57 Hz at 0.075 mm displacement amplitude sinusoid, and 9.8m/s^2 from 57 to 150 Hz. IEC 61800-5-1
Within the specifications given above, also do NOT allow the packaged drive (in box) to exceed the following conditions as per 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 cabinet ambient temperature of Duct Mounted Drives	0 to +55 °C
Permissible temperature of air entry to heatsinks of Duct Mounted Drives	0 to +45 °C
Permissible cabinet ambient temperature of Wall and Recessed Mounted Drives. See *10.4.4 Temperature Derating* for current derating above 40 ºC	0 to +50 °C
Relative Humidity	5 to 85% non-condensing
Mechanical Vibration	10 to 57 Hz at 0.075 mm displacement amplitude sinusoid, and 9.8m/s^2 from 57 to 150 Hz. IEC 61800-5-1
Unusual environmental conditions	Not provided beyond IEC 60146-1-1
Maximum installation altitude	1000 m above mean sea level
Operating dust and solid particles exposure limit	IEC 60664-1 Clean Air Pollution Degree 2
M6 mounting screw torque (use M6 SEMS screw assembly with captive washer)	3.0 Nm
DC Bus & PE M4 nyloc nut torque	1.5 Nm
Within the specifications given above, do NOT allow the PIU or drive to exceed the following conditions as per IEC 60721-3-3: climatic conditions 3K3, mechanical stress class 3M3, chemical influences class 3C2 and sand and dust class 3S2.	

Attribute	Qualification							
10.5.4 Duct Mount Cooling								
AMD5x Product Variant	15kW PIU	24kW PIU	3A Drive	6A Drive	12A Drive	20A Drive	35A Drive	35AH Drive
Heat-sink losses to duct at full rated continuous current	60 W	75 W	42 W	70 W	131 W	194 W	298 W	297 W
Losses to cabinet at full rated continuous current	16 W	18 W	11 W	14 W	21 W	28 W	37 W	37 W
10.5.5 Wall and Recessed Cooling								
AMD5x Product Variant	15kW PIU	24kW PIU	3A Drive	6A Drive	12A Drive	20A Drive	35A Drive	35AH Drive
Losses to cabinet at full rated continuous current*	82 W	100 W	59 W	90 W	158 W	235 W	354 W	353 W
Number of fans	1	1	1	1	1	2	3	3
Fan variable speed control and locked rotor monitor	Yes							

*These loss figures include fan losses.

Attribute	***Qualification***

10.5.6 Physical Characteristics

Degree of Ingress Protection (IP Rating)	IP 20 in accordance with EN60529[5]
Mounting position in Operation	Vertical

10.5.7 15kW and 24kW PIU Physical Characteristics

	Duct Mount	**Wall Mount**	**Recessed Mount**
Device Weight	4.1kg	6.1kg	6.1kg
Height (mm)	362	362	362
Width (mm)	125	125	125
Depth (mm)	191	157	157

10.5.8 Drive Physical Characteristics

	Duct Mount		**Wall Mount**		**Recessed Mount**	
Excluding IO Interface	***3A, 6A, 12A and 20A***	***35A and 35AH***	***3A, 6A, 12A and 20A***	***35A and 35AH***	***3A, 6A, 12A and 20A***	***35A and 35AH***
Device Weight	3.0kg	4.4kg	4.5kg	6.5kg	4.5kg	6.5kg
Height (mm)	362	362	362	362	362	362
Width (mm)	89	125	89	125	89	125
Depth (mm)	191	191	157	157	157	157
Including IO Interface	***3A, 6A, 12A and 20A***	***35A and 35AH***	***3A, 6A, 12A and 20A***	***35A and 35AH***	***3A, 6A, 12A and 20A***	***35A and 35AH***
Device Weight	3.0kg	4.4kg	4.5kg	6.5kg	4.5kg	6.5kg
Height (mm)	362	362	362	362	362	362
Width (mm)	89	125	89	125	89	125
Depth (mm)[6]	193	193	159	159	159	159

10.5.9 Capacitor Module Physical Characteristics

Device Weight	3.1kg	3.2kg	3.1kg
Height (mm)	362	362	362
Width (mm)	125	89	125
Depth (mm)	111	157	111

[5] 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.
[6] Depth of Drive variants with BiSS Interface will be 2mm less than the IO Interface dimensions.

10.6 Dimension Drawings

10.6.1 **15kW and 24kW PIU Physical Dimensions**

Physical dimensions for Duct mount (
Figure 10-2), Wall mount(
Figure 10-3) and Recessed mount(
Figure 10-4) for PIU.

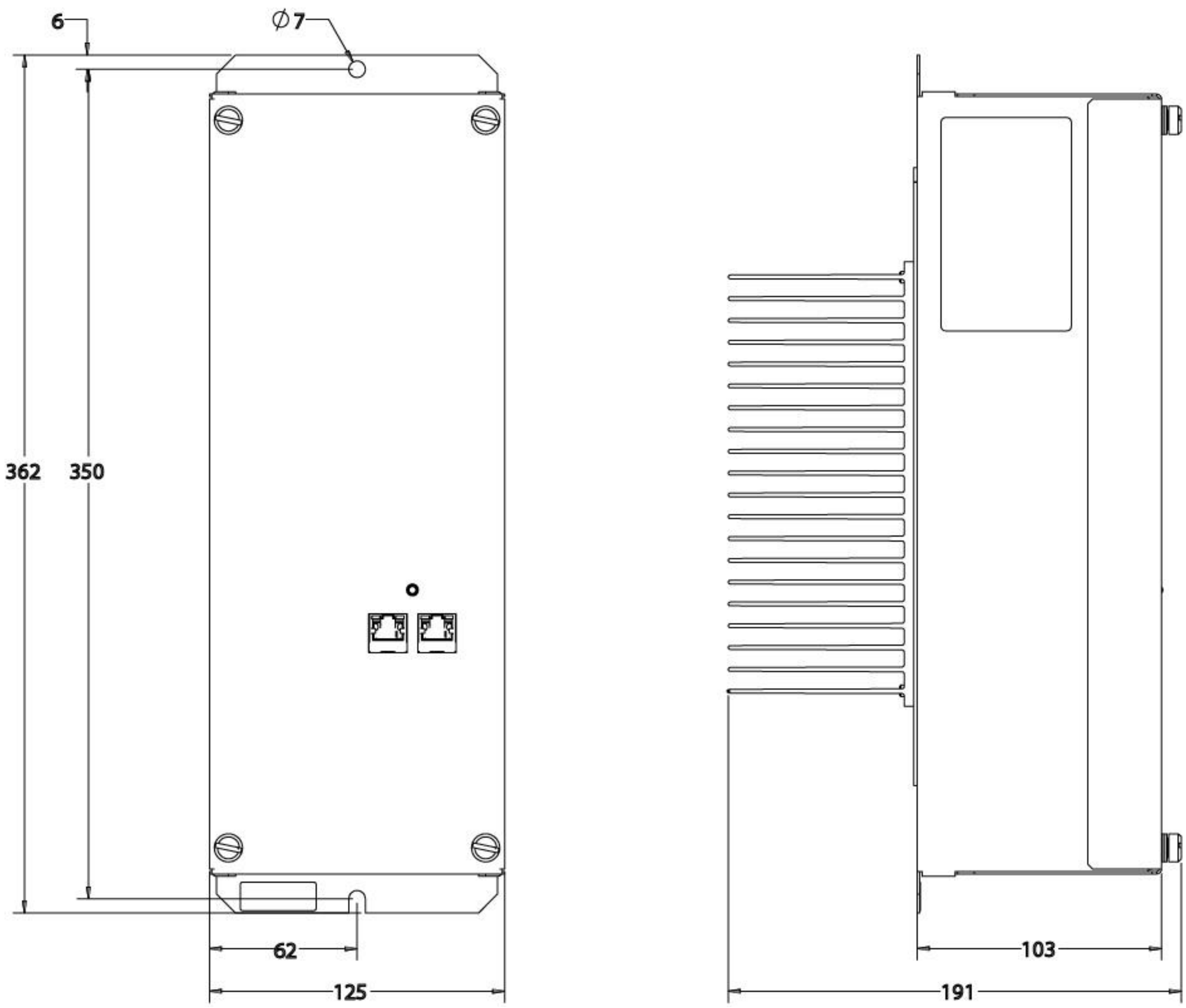


Figure 10-2: 15kW and 24kW PIU dimensions Duct mount

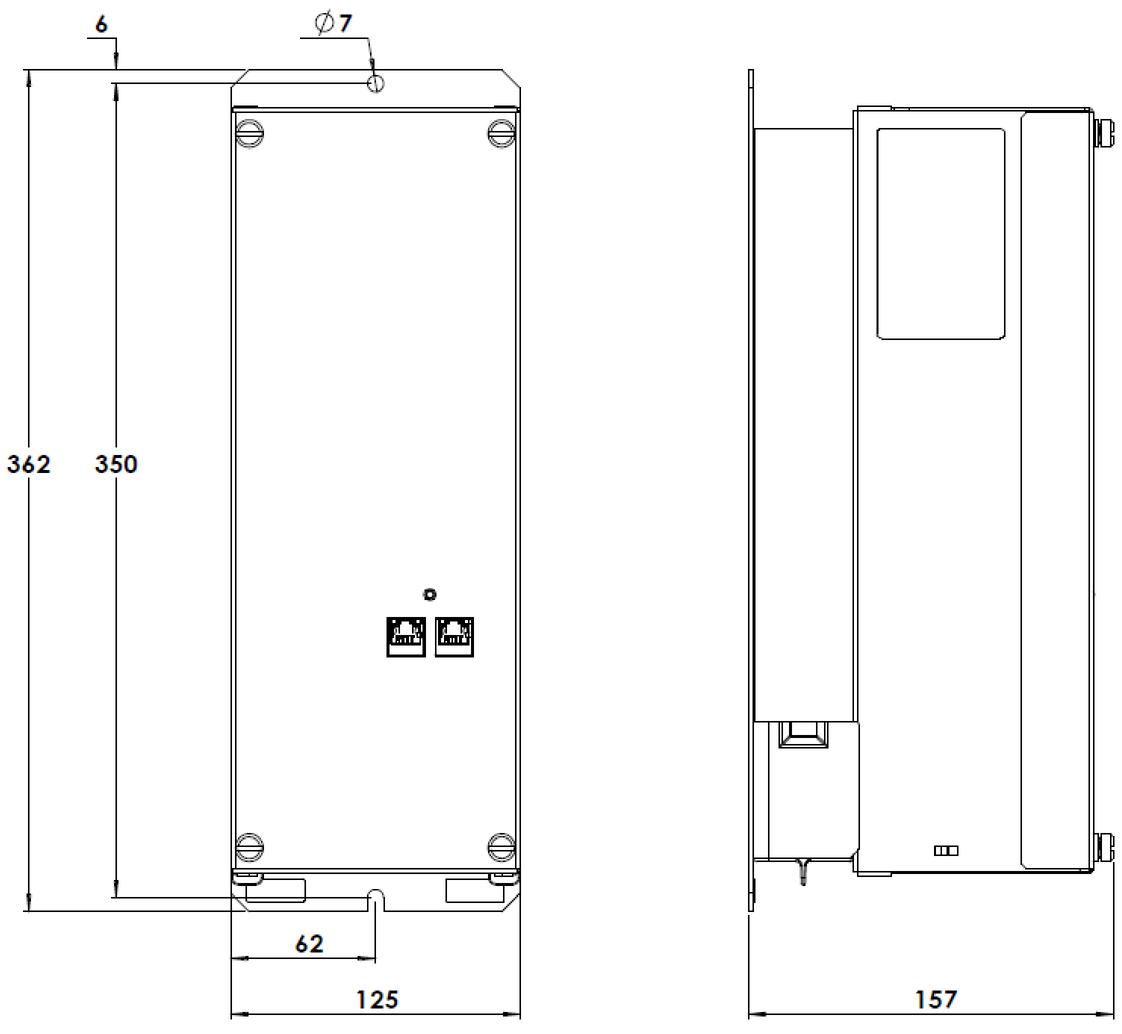


Figure 10-3: 15kW and 24kW PIU dimensions Wall mount

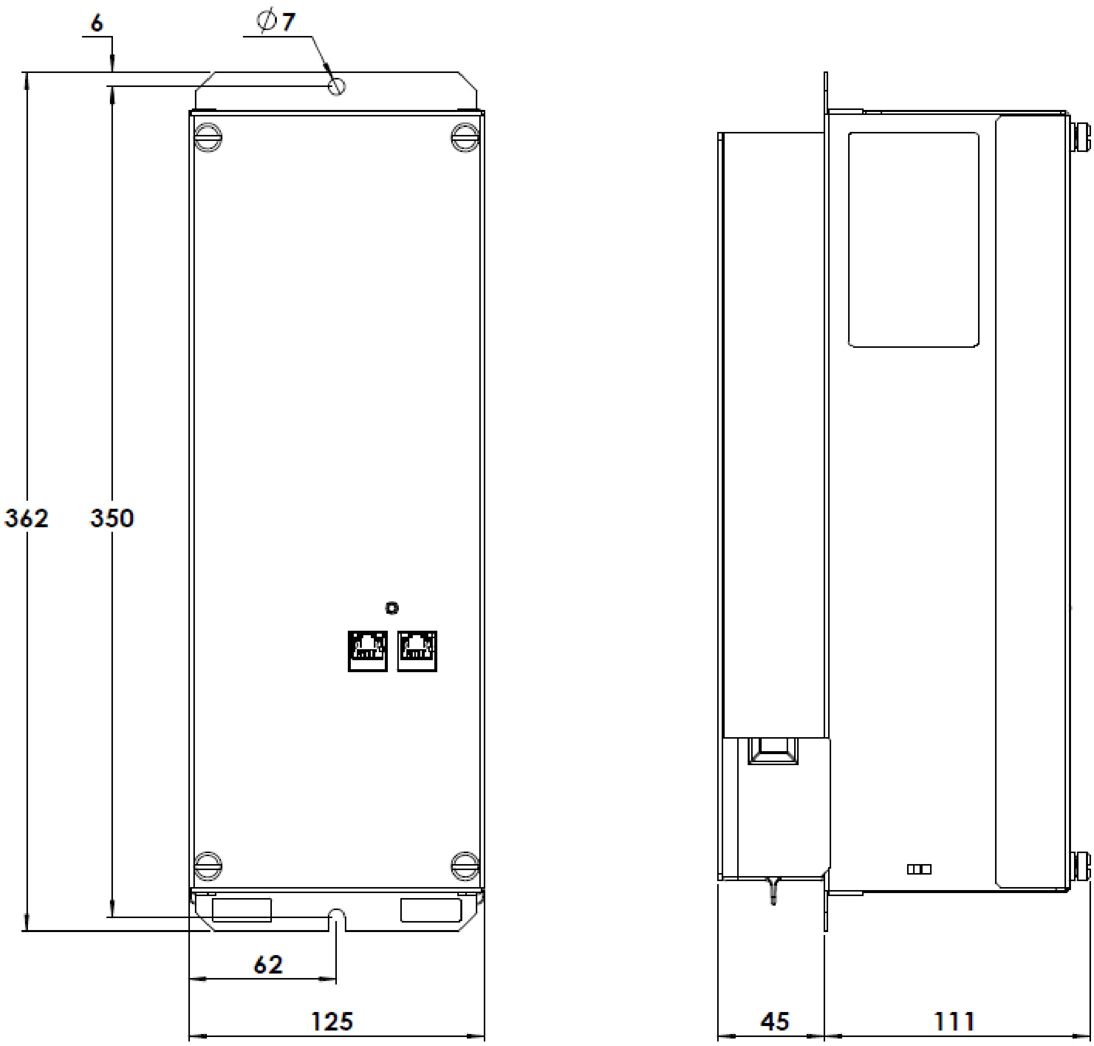


Figure 10-4: 15kW and 24kW PIU dimensions Recessed mount

10.6.2 15kW and 24kW PIU Mounting Hole Positions and Heatsink Cut-Out Specifications

Mounting hole positions and heatsink cut outs for Duct(
Figure 10-5) and Wall(
Figure 10-6) mount PIU.

Drill and tap two mounting holes to M6x1.0

The sheet metal panel should be a minimum 3mm thick.

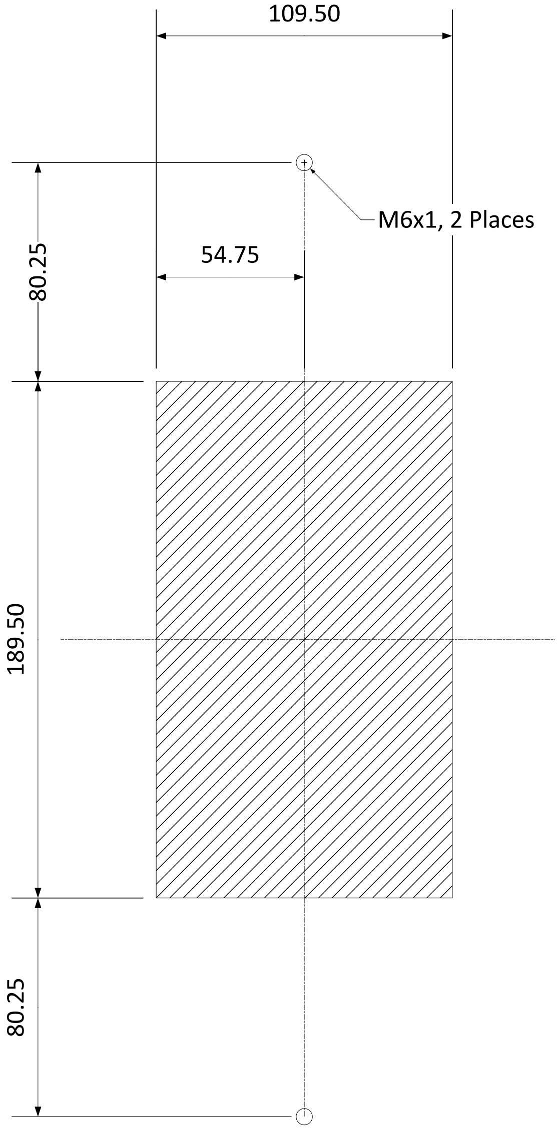


Figure 10-5: Mounting hole and cut-out specifications for PIU Duct mount

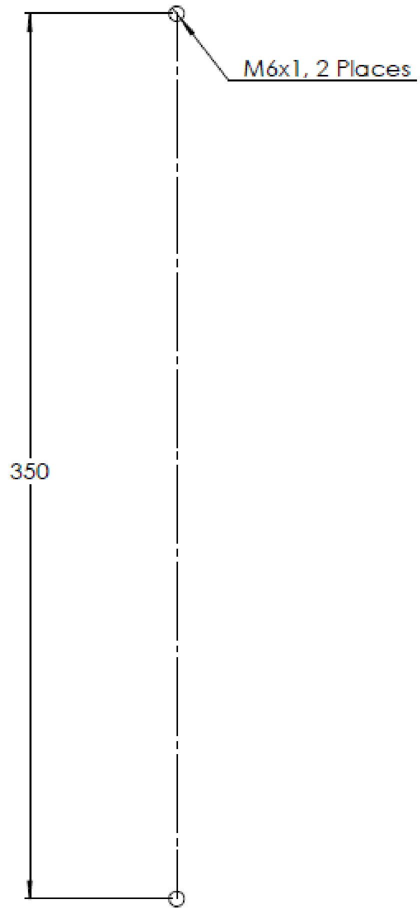


Figure 10-6: Mounting holes for PIU Wall mount

For Recessed Mount heatsink hole cut out details refer to *Figure 10-26* and *Figure 10-30*.

10.6.3 35A and 35AH Drive Mounting Hole Positions and Physical Dimensions

Mounting hole positions and physical dimensions for Duct mount(

Figure 10-7), Duct mount with IO interface(

Figure 10-8), Wall mount(

Figure 10-9), Wall mount with IO interface(

Figure 10-10), Recessed mount(

Figure 10-11) and Recessed mount with IO interface(

Figure 10-12) 35A Drives.

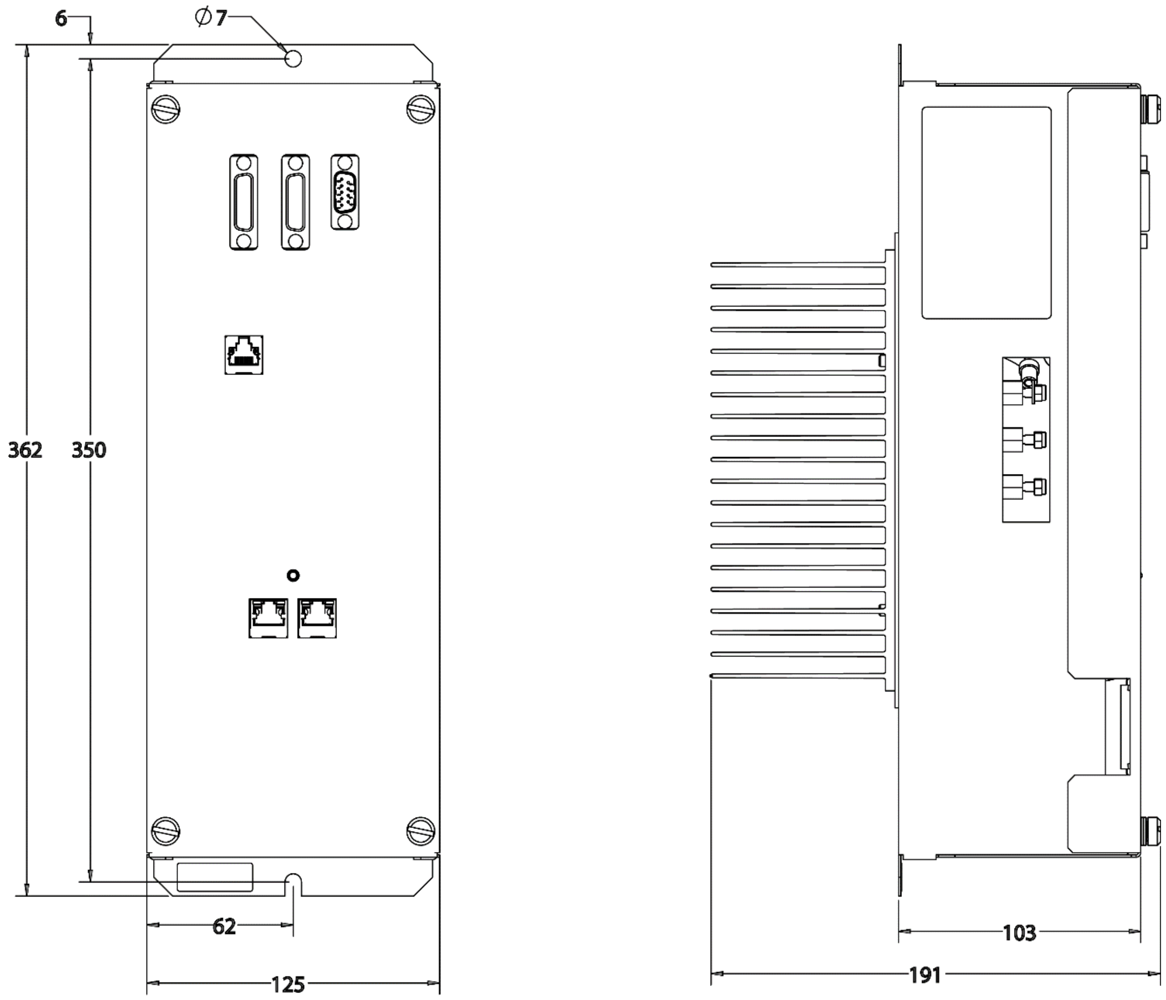


Figure 10-7: 35A and 35AH Drive dimensions (without IO Interface) Duct mount

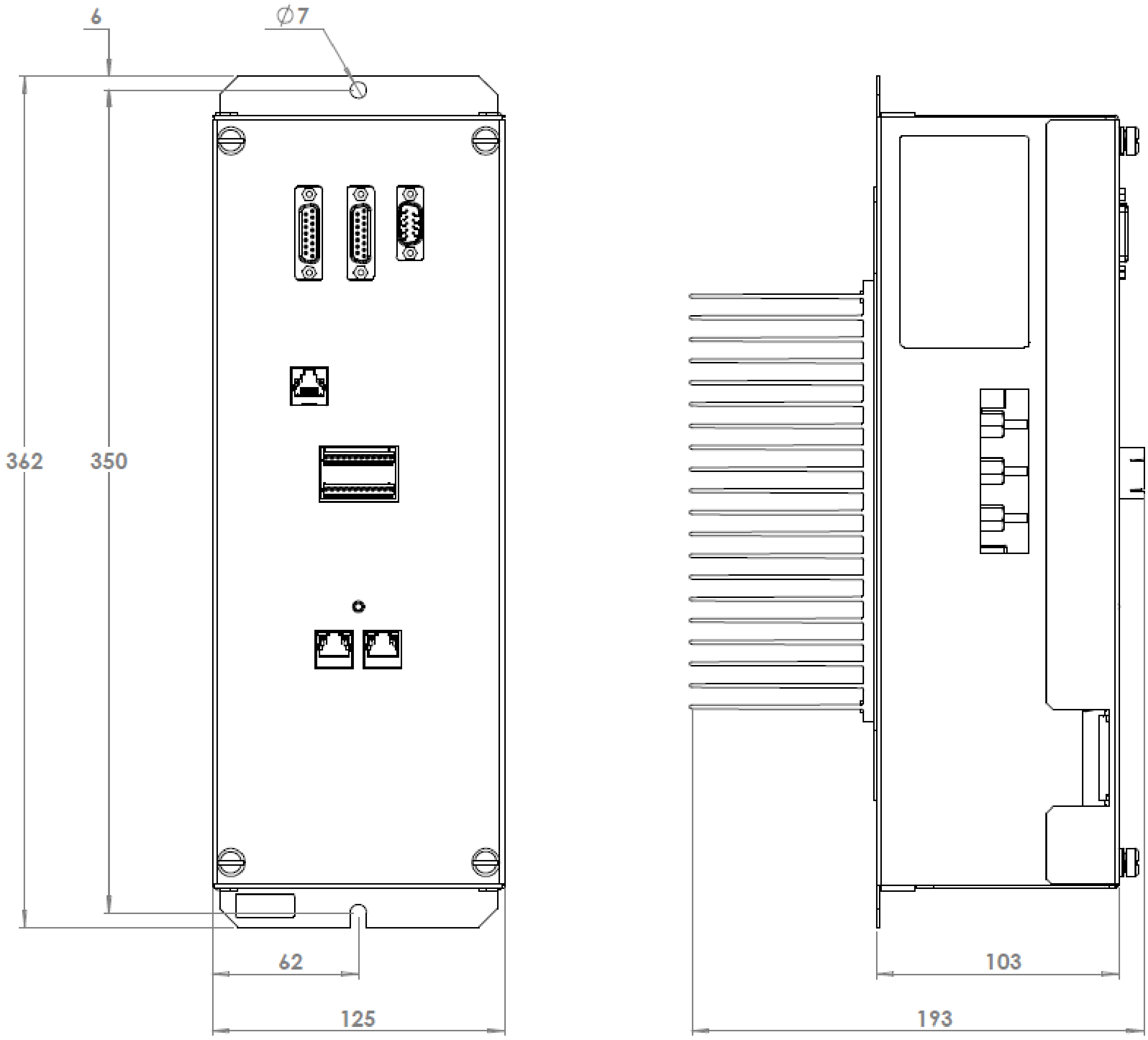


Figure 10-8: 35A and 35AH Drive dimensions (with IO Interface) Duct mount

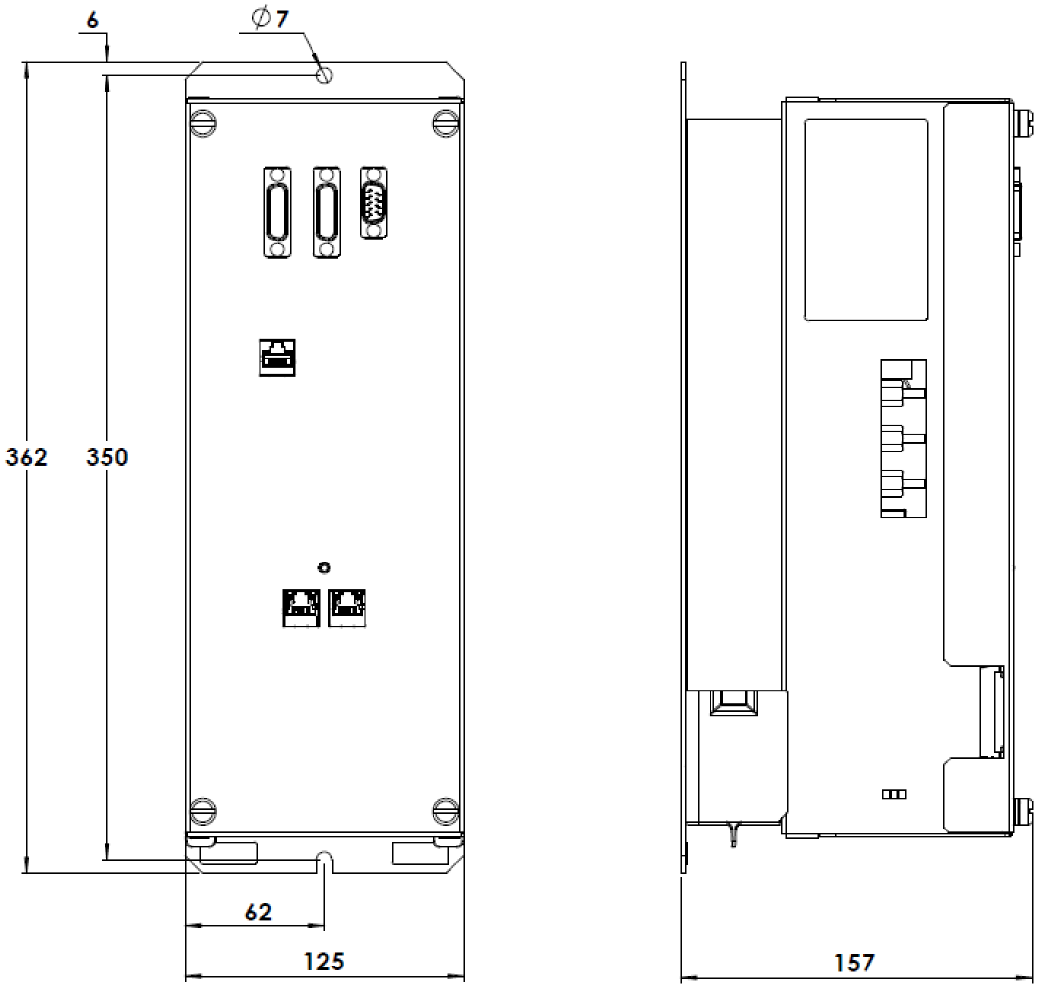


Figure 10-9: 35A and 35AH Drive dimensions (without IO Interface) Wall mount

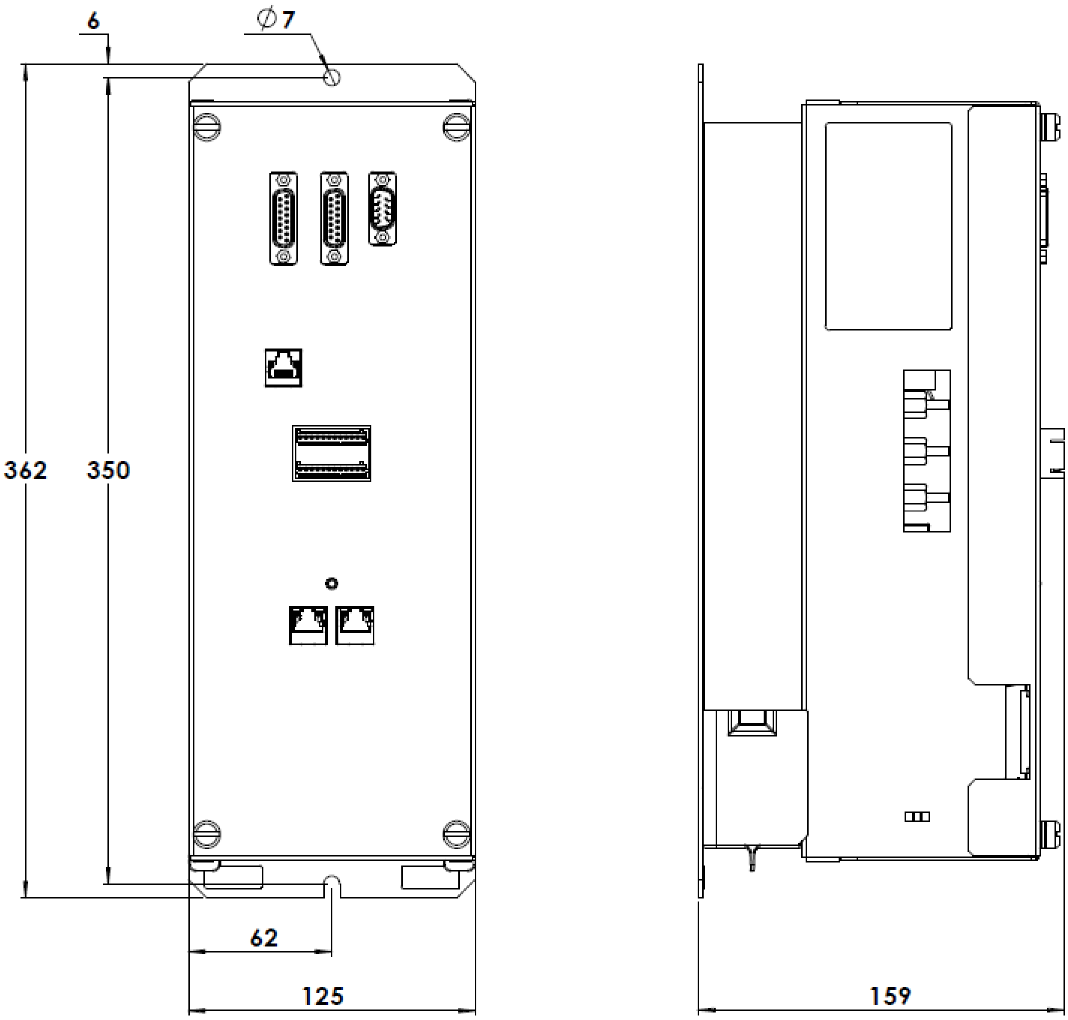


Figure 10-10: 35A and 35AH Drive dimensions (with IO Interface) Wall mount

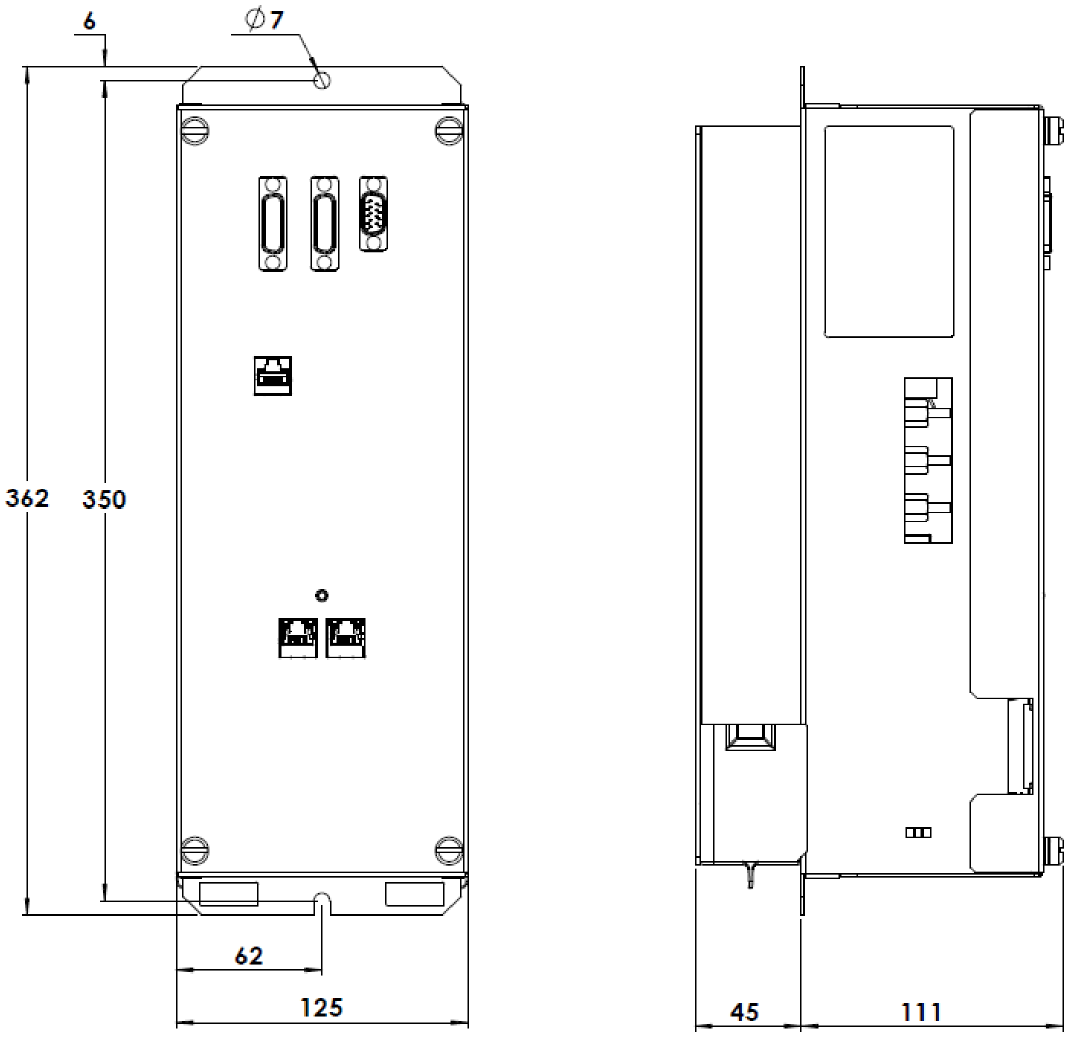


Figure 10-11: 35A and 35AH Drive dimensions (without IO Interface) Recessed mount

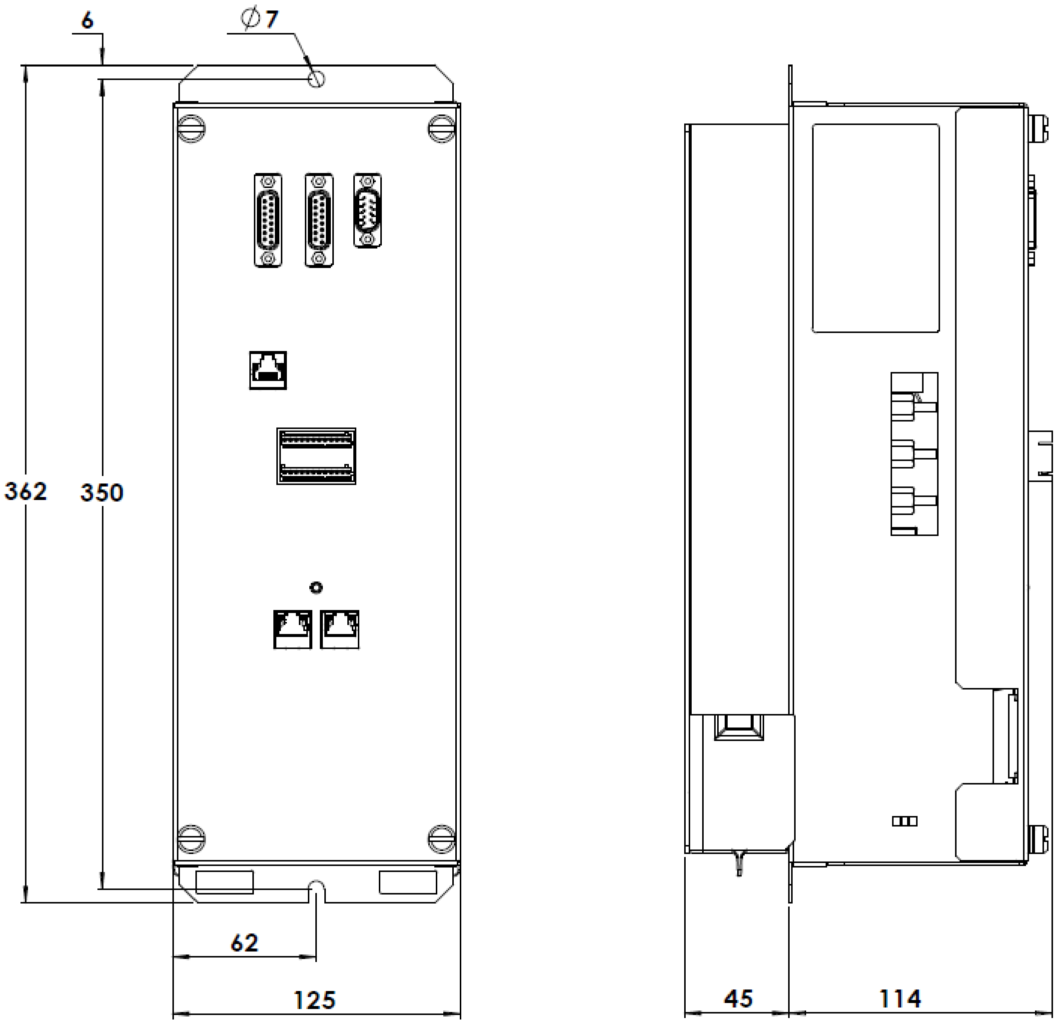


Figure 10-12: 35A and 35AH Drive dimensions (with IO Interface) Recessed mount

10.6.4 3A, 6A, 12A & 20A Drive Mounting Hole Positions and Physical Dimensions

Mounting hole positions and physical dimensions for Duct mount(

Figure 10-13), Duct mount with IO interface (

Figure 10-14), Wall mount (

Figure 10-15), Wall mount with IO interface (

Figure 10-16), Recessed mount (

Figure 10-17) and Recessed mount with IO interface (

Figure 10-18) 3A, 6A, 12A and 20A Drives.

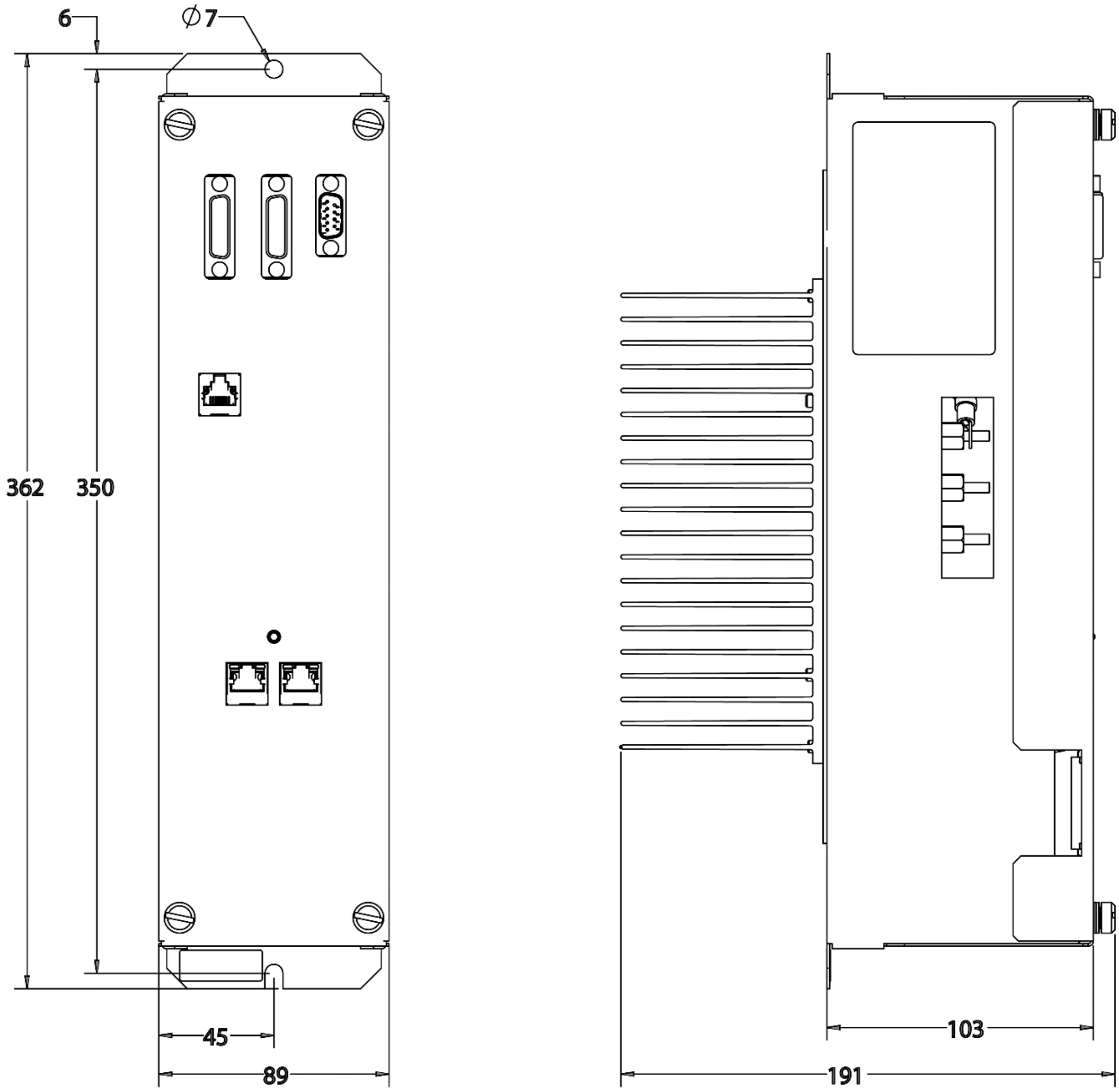


Figure 10-13: 3A, 6A, 12A & 20A Drive dimensions (without IO Interface) Duct mount

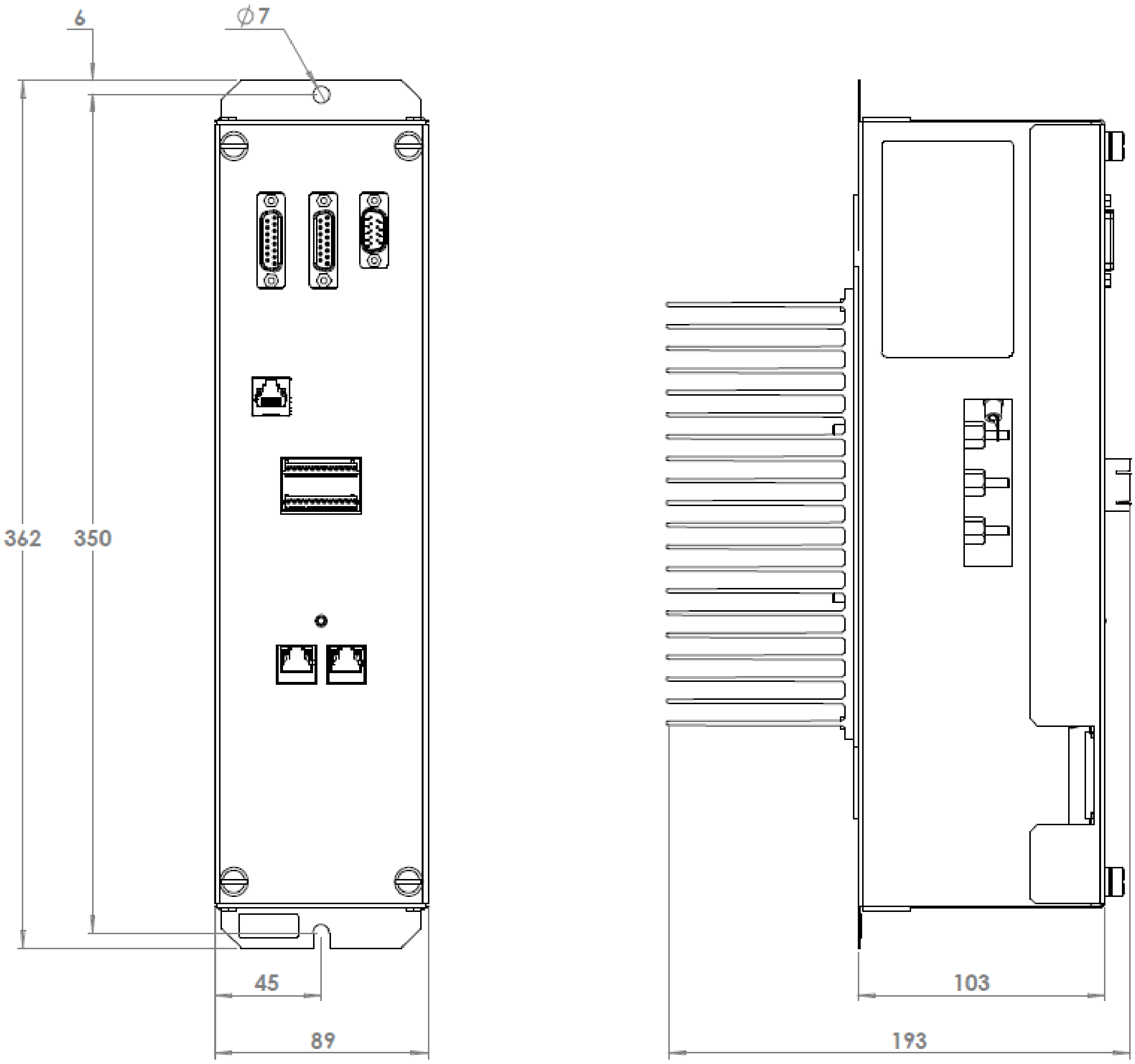


Figure 10-14: 3A, 6A, 12A & 20A Drive dimensions (with IO Interface) Duct mount

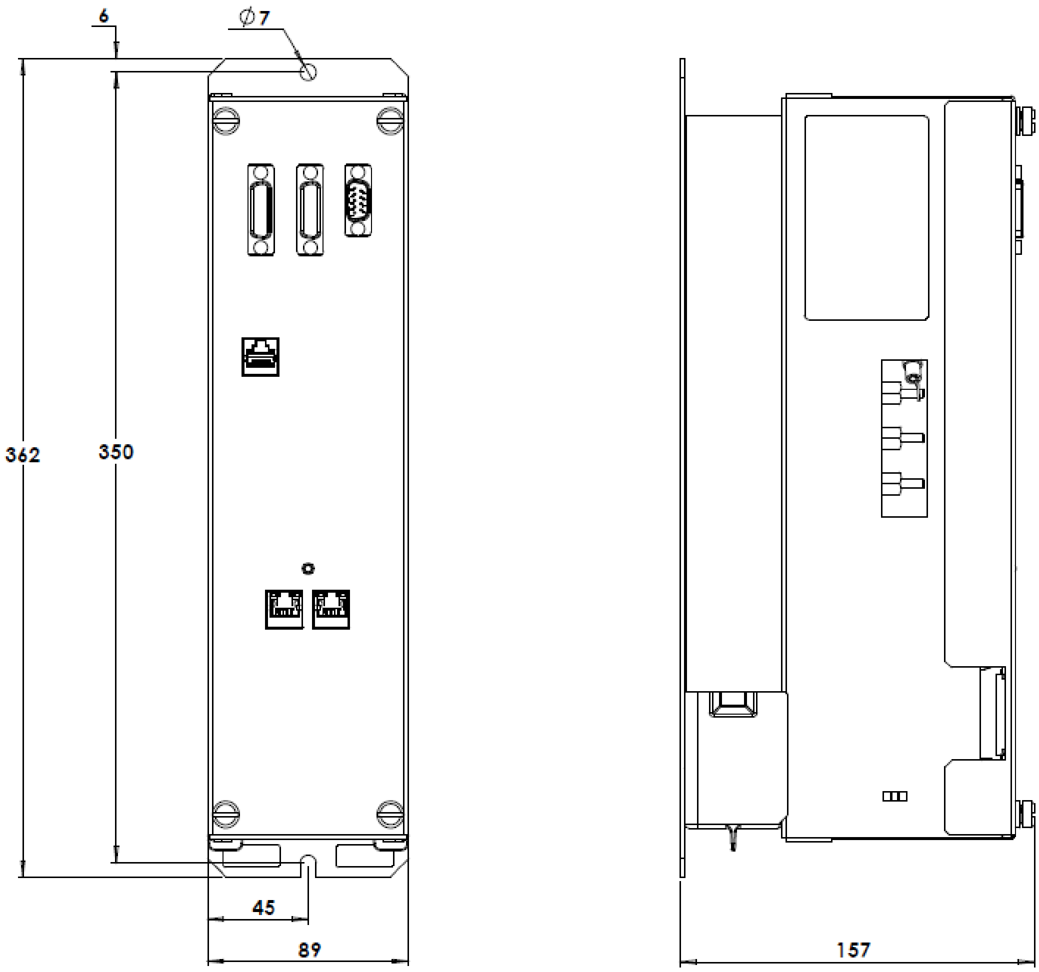


Figure 10-15: 3A, 6A, 12A & 20A Drive dimensions (without IO Interface) Wall mount

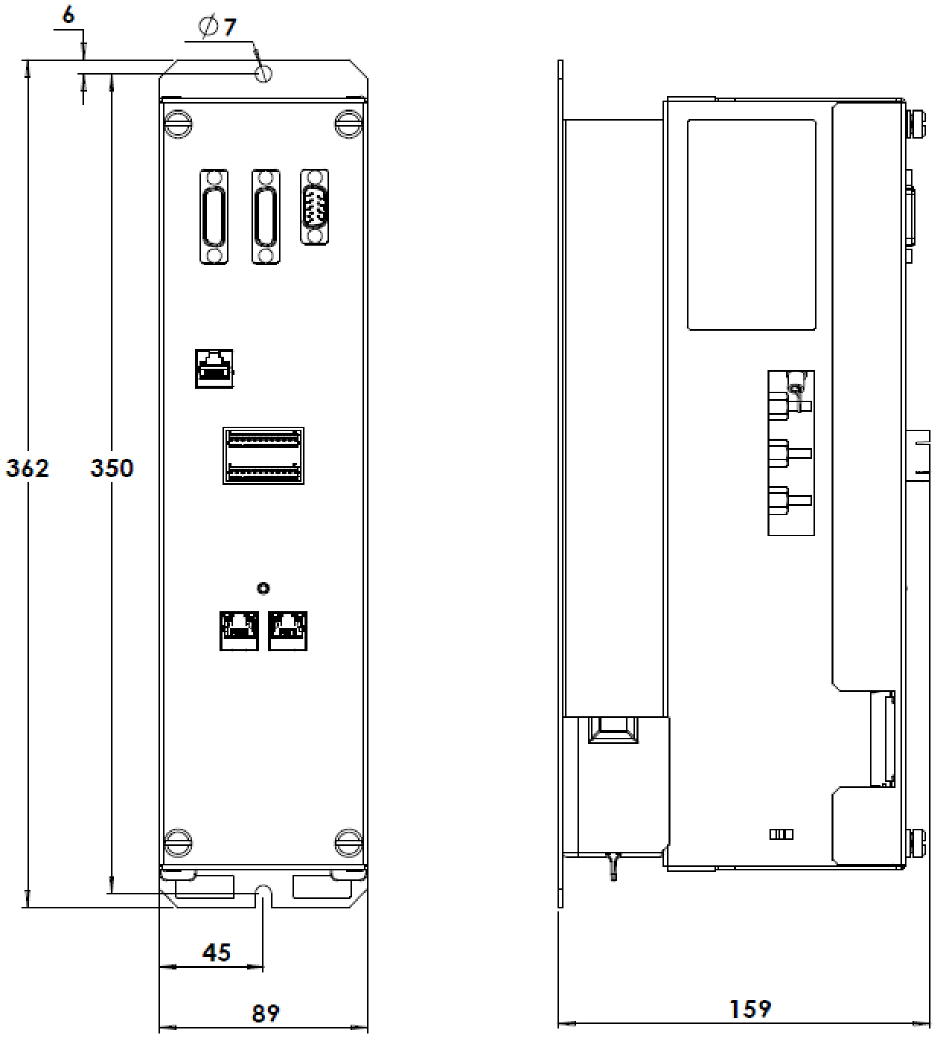


Figure 10-16: 3A, 6A, 12A & 20A Drive dimensions (with IO Interface) Wall mount

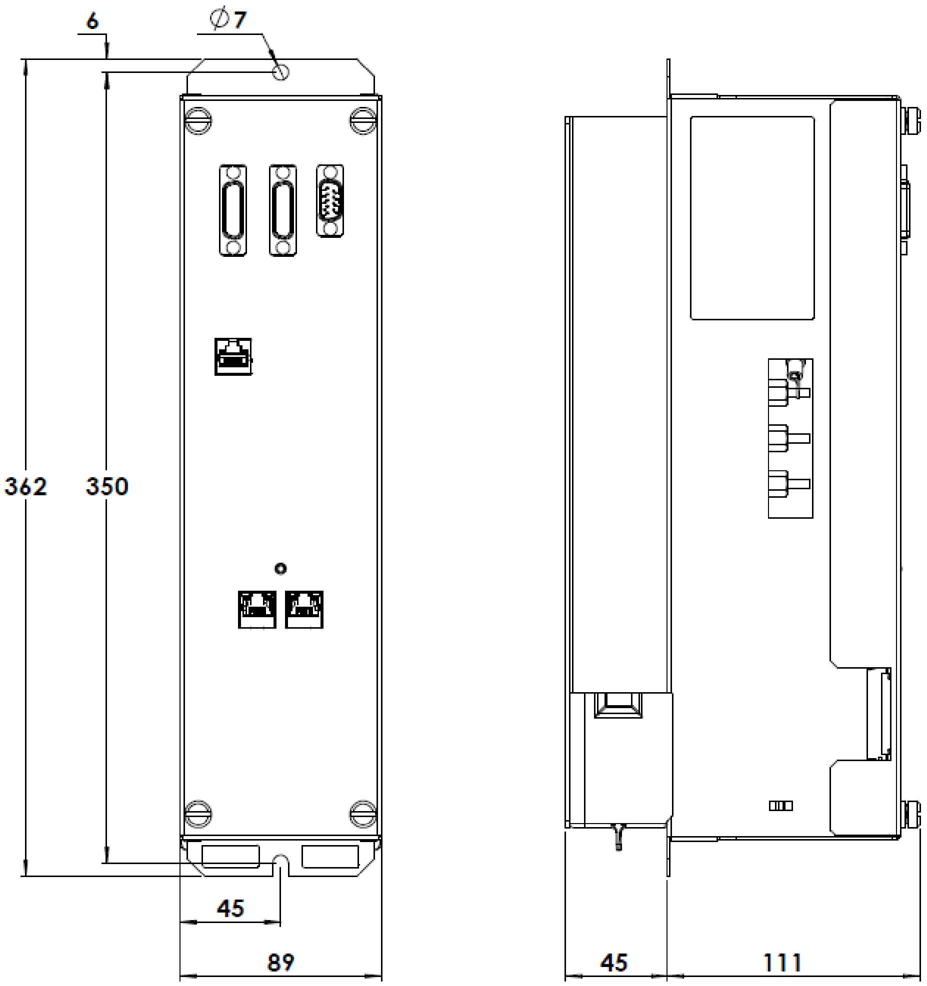


Figure 10-17: 3A, 6A, 12A & 20A Drive dimensions (without IO Interface) Recessed mount

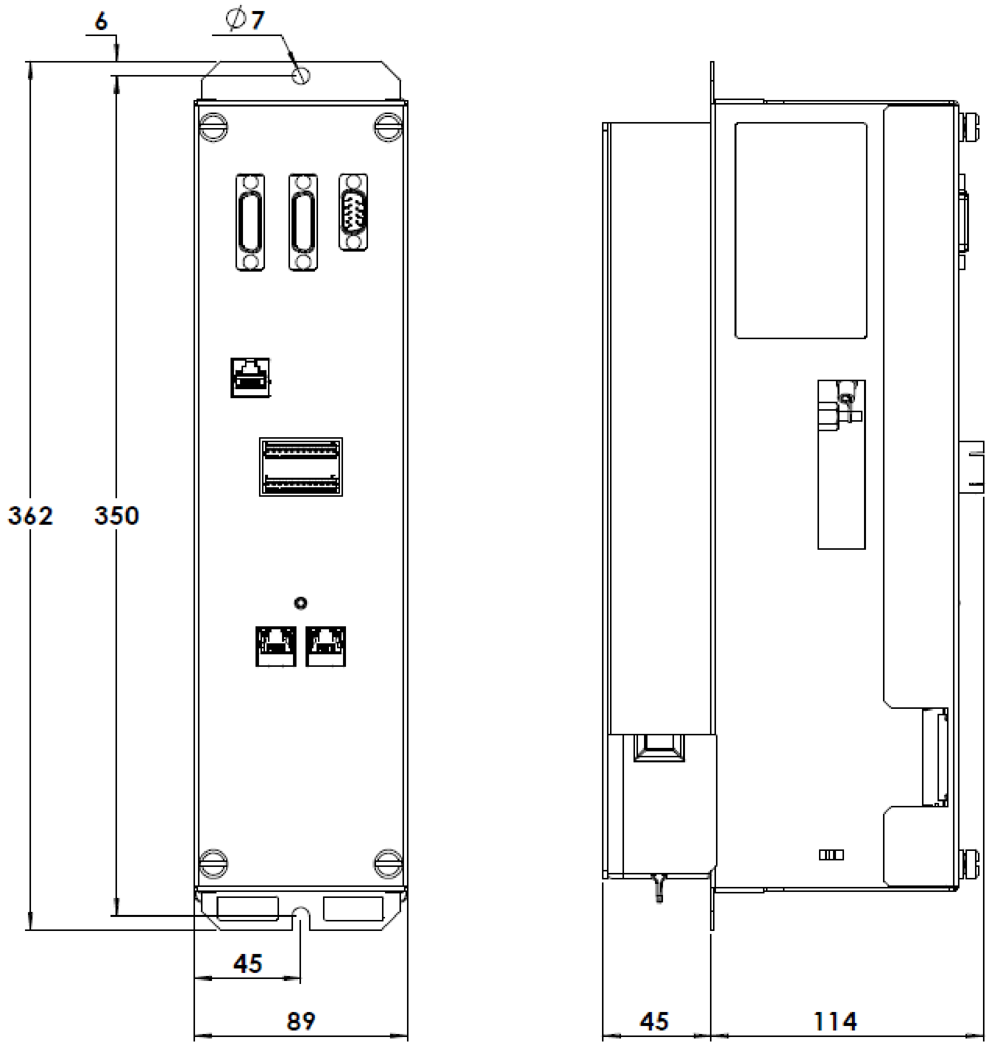


Figure 10-18: 3A, 6A, 12A & 20A Drive dimensions (with IO Interface) Recessed mount

10.6.5 Drive Mounting Hole Positions and Heatsink Cut-Out Specifications

Mounting hole positions and heatsink cut outs for Duct (*Figure 10-19*) and Wall (

Figure 10-20) mount 3A, 6A, 12A, 20A, 35A and 35AH Drives.

For each drive, drill and tap two mounting holes to M6x1.0

The sheet metal panel should be a minimum 3mm thick.

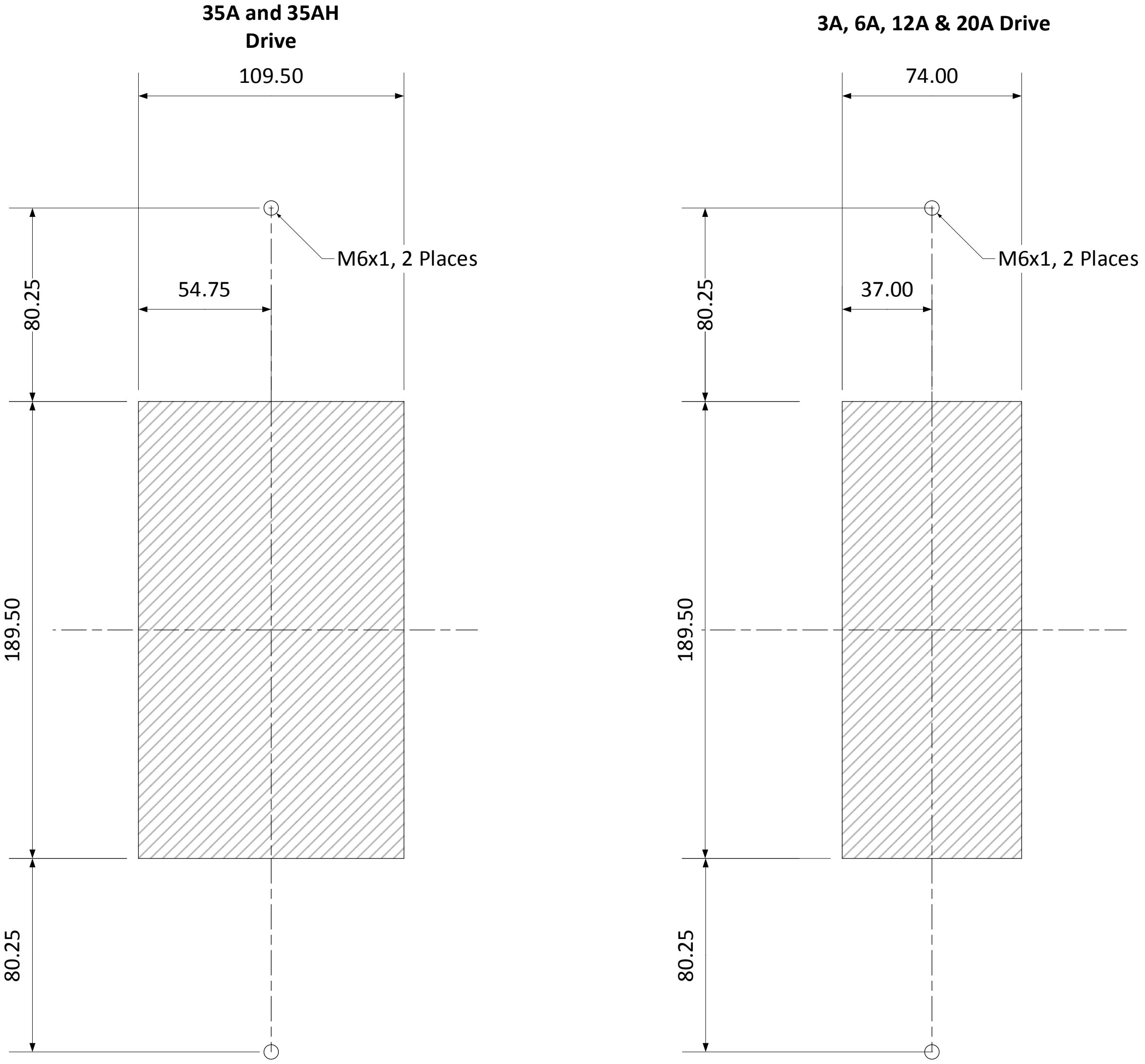


Figure 10-19: Mounting hole & cut-out specifications for 3A, 6A, 12A, 20A, 35A & 35AH Duct mount Drives

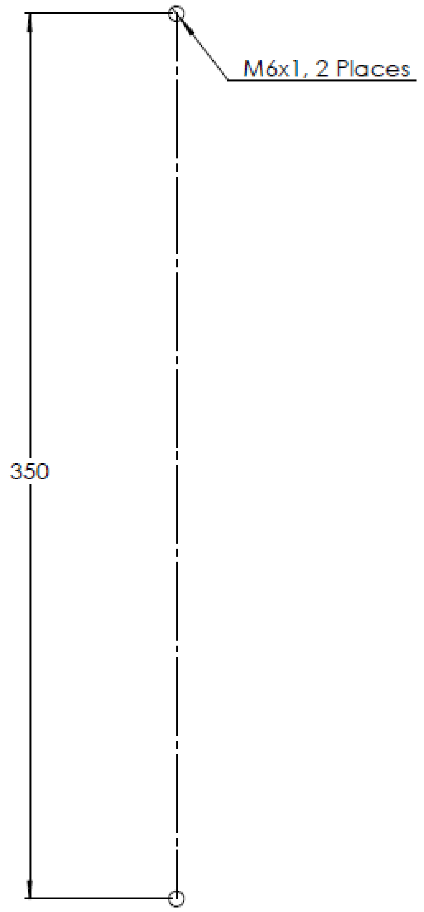


Figure 10-20: Mounting hole & cut-out specifications for 3A, 6A, 12A, 20A, 35A & 35AH Wall mount Drives

For Recessed Mount heatsink hole cut out details refer to *Figure 10-26* and *Figure 10-30*.

10.6.6 Capacitor Module Physical Dimensions

Physical dimensions of Duct & Recessed (
Figure 10-21) and Wall (*Figure 10-22*) mount Capacitor Modules.

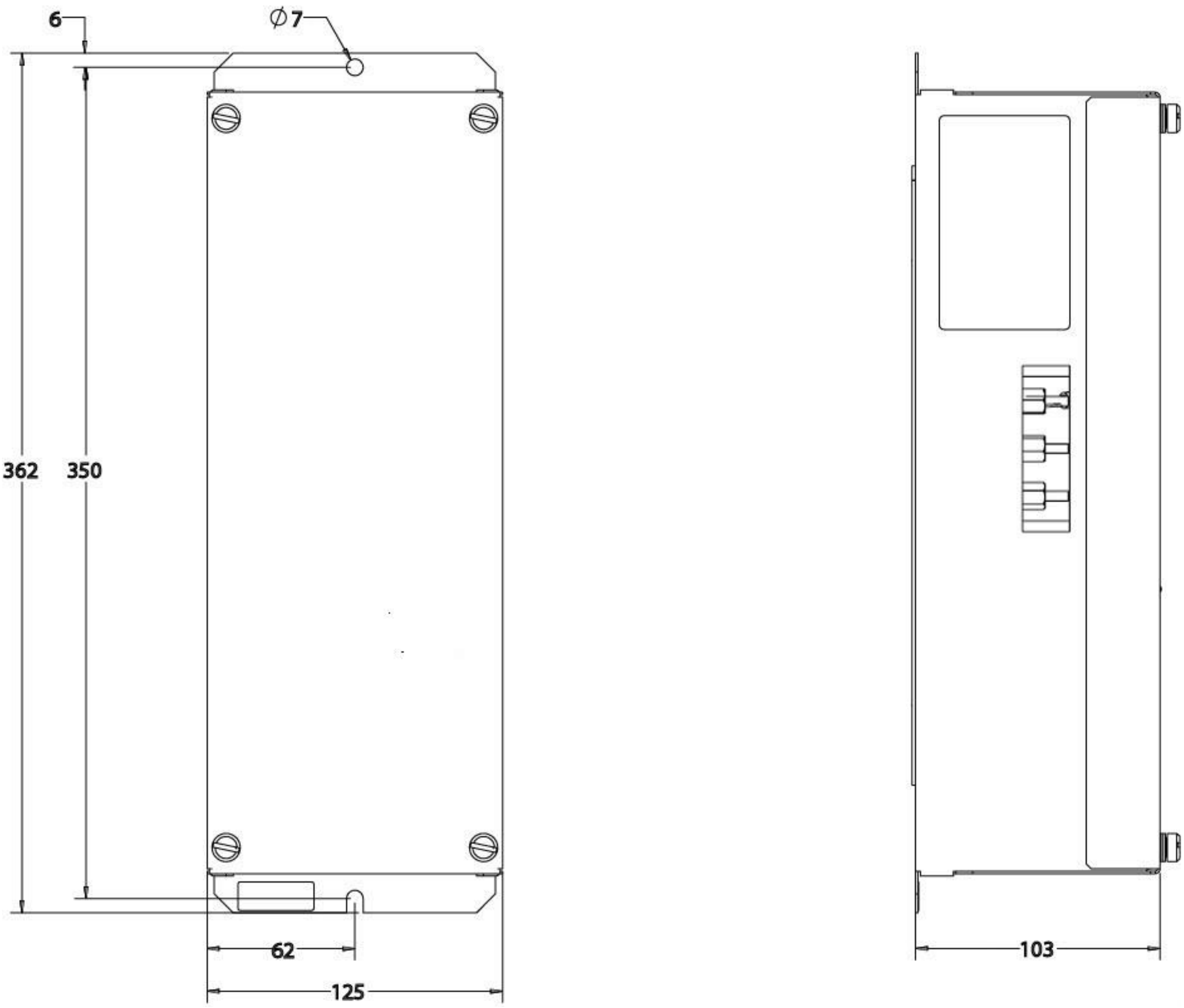


Figure 10-21: Capacitor Module dimensions for Duct and Recessed mount

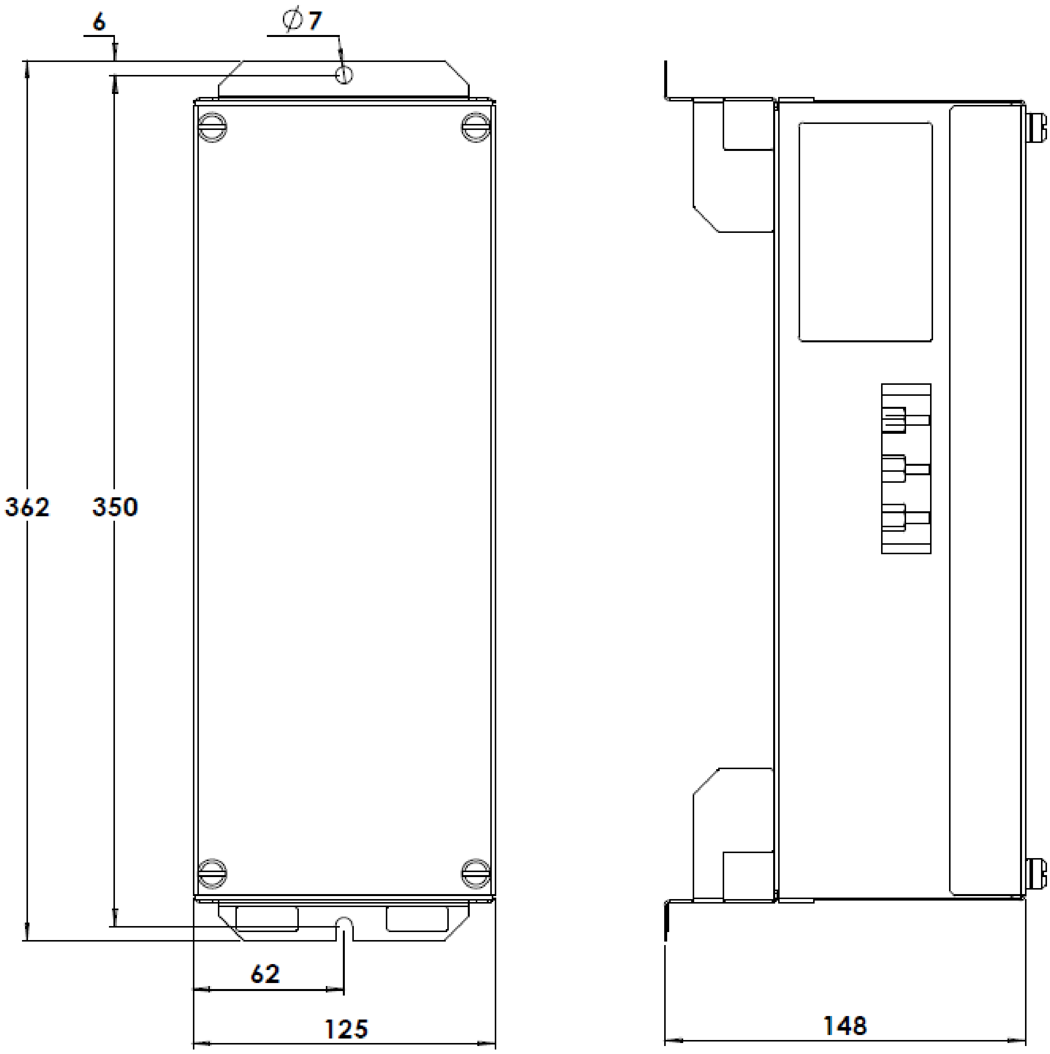


Figure 10-22: Capacitor Module dimensions for Wall mount

10.6.7 Capacitor Module Mounting Hole Positions

The capacitor module has the same mounting hole positions as the 15kW and 24kW PIU. See section *10.6.1 15kW and 24kW PIU* Physical Dimensions

No heatsink cut-out is required.

10.6.8 PIU, 35A, 20A, and 12A/6A/3A Drives and Capacitor Module Mounting Hole Positions

Mouting hole positions for Duct, Wall and Recessed mount Array PIU, 35A, 20A, 12A/6A/3A Drives and Capacitor Module (*Figure 10-23*).

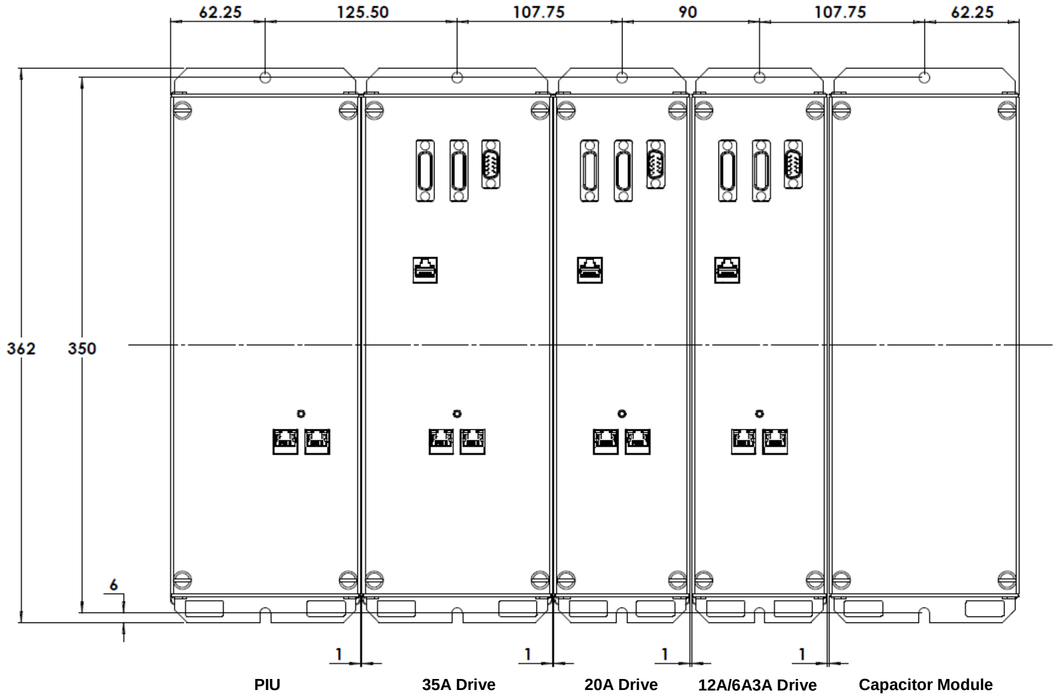


Figure 10-23: PIU, 35A, 20A, 12A/6A/3A drives and Capacitor Module mounting hole positions for Duct, Wall and Recessed mounting Array

10.6.9 PIU, 35A, 20A and 12A/6A/3A Drives Heat sink Cut-Out Specifications

Heat sink cut-out specifications for Duct (*Figure 10-24*), Wall (*Figure 10-25*) and Recessed (*Figure 10-26*) mount PIU, 35A, 20A and 12A/6A/3A drives and Capacitor Module.

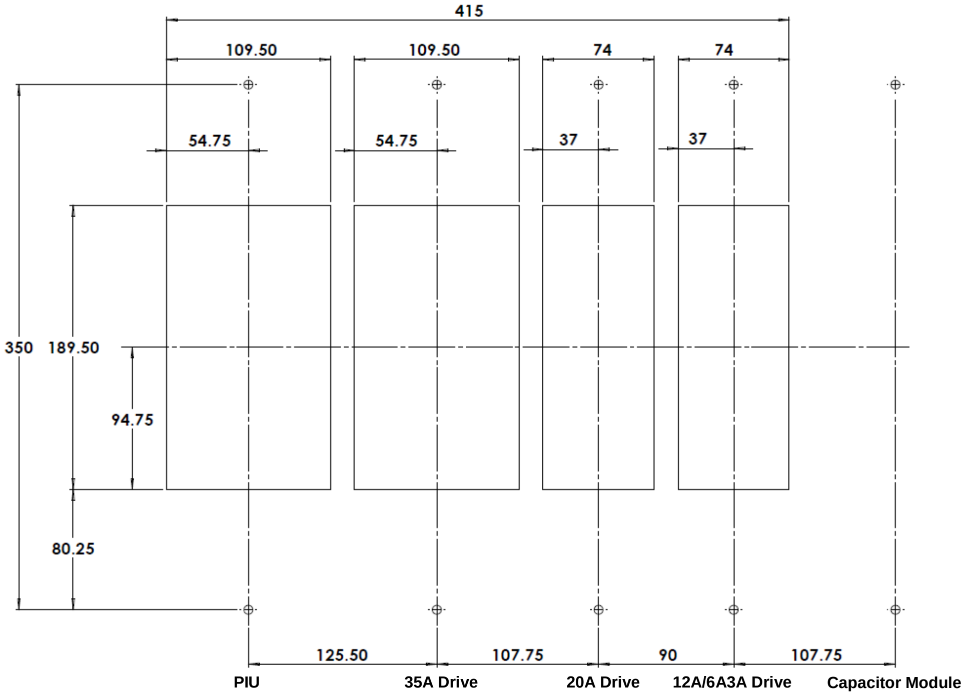


Figure 10-24: PIU, 35A, 20A and 12A/6A/3A drives heatsink cut-outs and Capacitor Module mounting hole positions in an array Duct mount

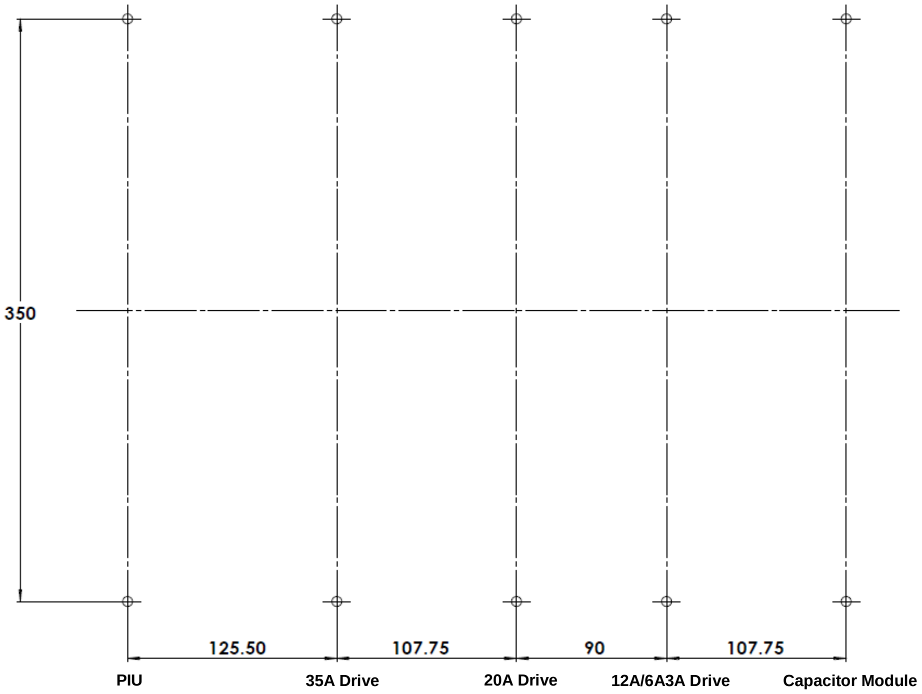


Figure 10-25: PIU, 35A, 20A and 12A/6A/3A drives heatsink cut-outs and Capacitor Module mounting hole positions in an array Wall mount

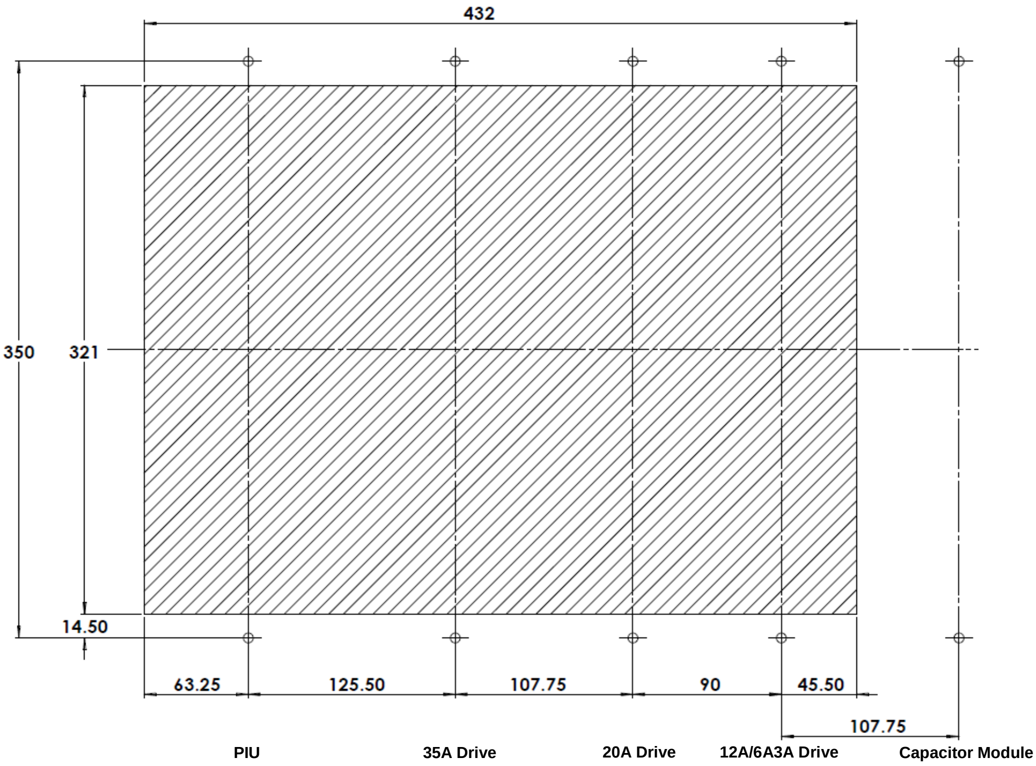


Figure 10-26: PIU, 35A, 20A and 12A/6A/3A drives heatsink cut-outs and Capacitor Module mounting hole positions in an array Recessed mount

10.6.10 PIU, 20A and 12A/6A/3A Drives and Capacitor Module Mounting Hole Positions

Mounting hole positions for Duct, Wall and Recessed mount Array PIU, 20A, and 12A/6A/3A Drives and Capacitor Module(*Figure 10-27*).

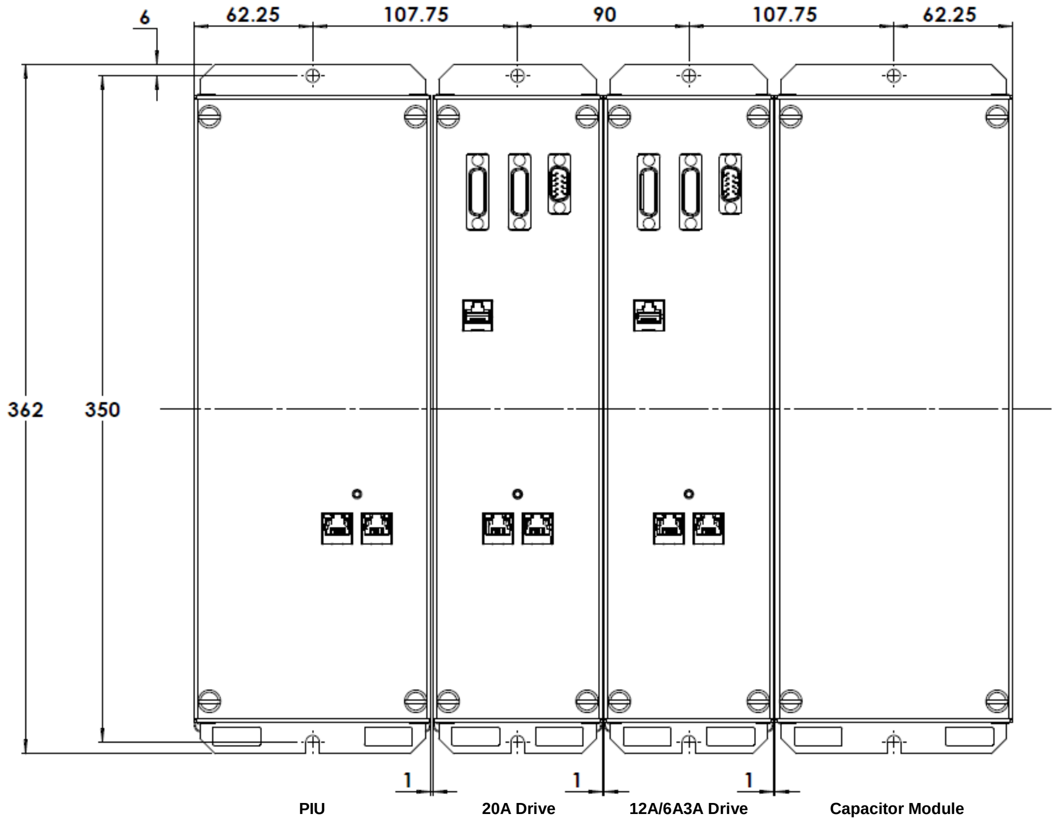


Figure 10-27: PIU, 20A and 12A/6A/3A drives and Capacitor Module mounting hole positions for Duct, Wall and Recessed mounted Array

10.6.11 PIU, 20A and 12A/6A/3A Drives Heat Sink Cut-Out Specifications

Heat sink cut-out specifications for Duct (*Figure 10-28*), Wall (*Figure 10-29*) and Recessed (*Figure 10-30*) mount PIU, 20A/12A/6A drives and Capacitor Module.

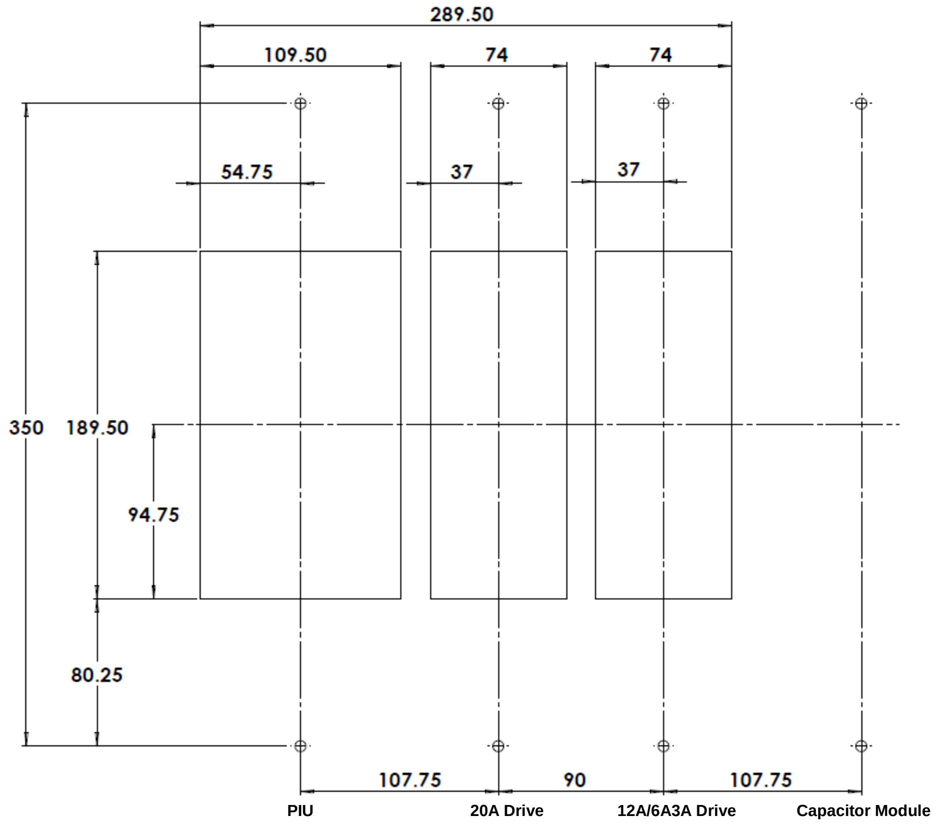


Figure 10-28: PIU, 20A and 12A/6A/3A drives heatsink cut-outs and Capacitor Module hole mounting hole positions in an array Duct mount

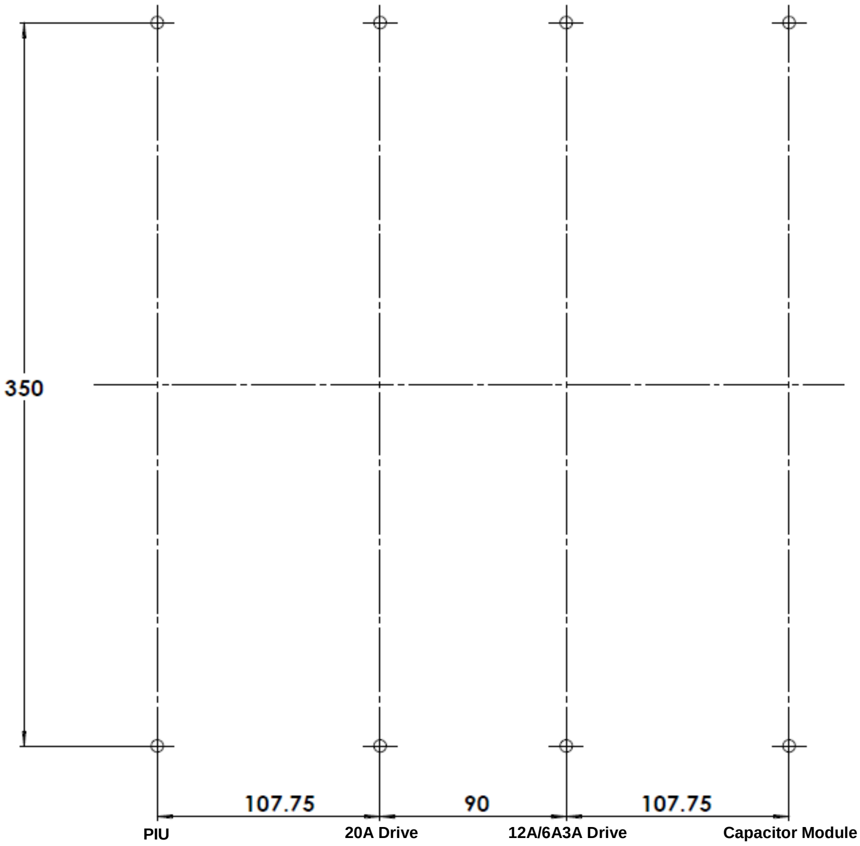


Figure 10-29: PIU, 20A and 12A/6A/3A drives heatsink cut-outs and Capacitor Module hole mounting hole positions in an array Wall mount

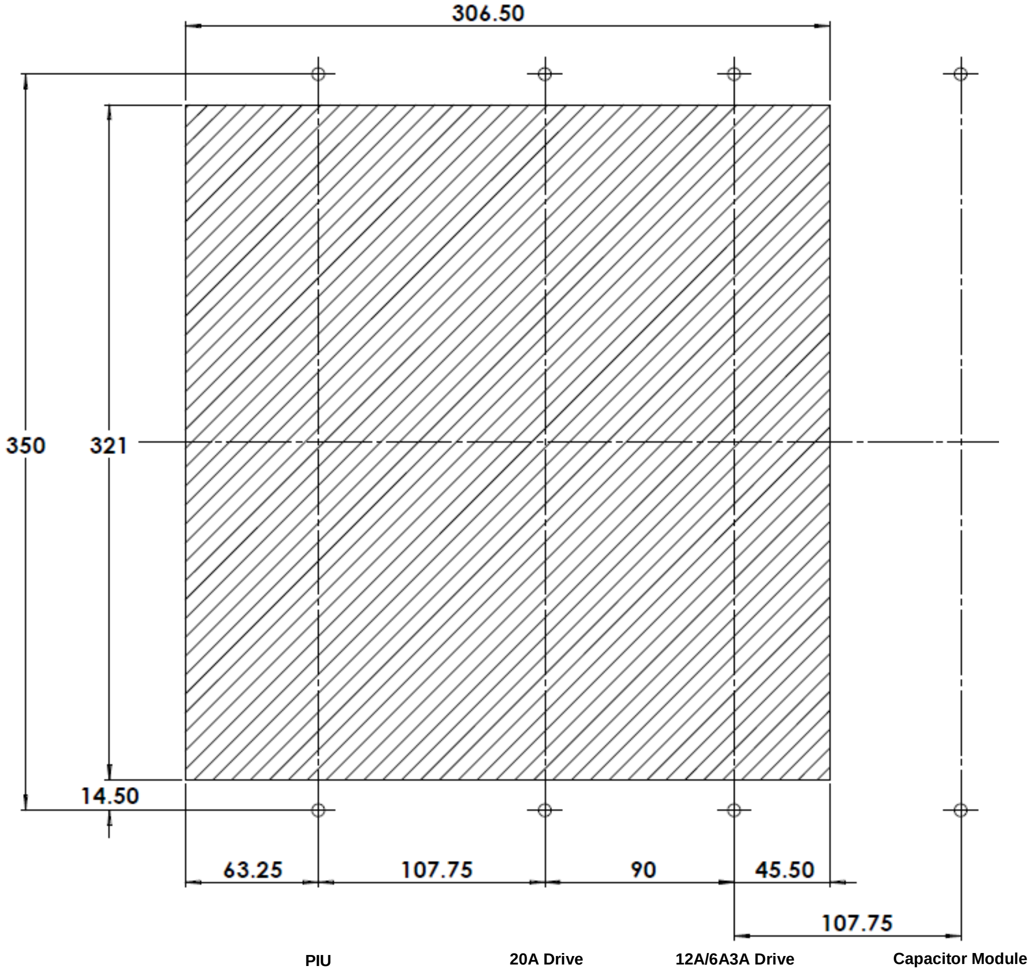


Figure 10-30: PIU, 20A and 12A/6A/3A drives heatsink cut-outs and Capacitor Module hole mounting hole positions in an array Recessed mount

10.7 Materials

Information regarding the materials used in the AMD5x PIU and Drives is shown in **Table 42: AMD5x PIU and Drive Materials***Table 42.*

Table 42: AMD5x PIU and Drive Materials	
Enclosure:	The AMD5x Drive and PIU chassis (main, sub, and fan) are stainless steel 304 with a silver paint finish. The AMD5x PIU and Drive heat-sinks are aluminium 6063 T5.
Packaging:	Cardboard, EPE
Disposal:	The PIU and 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 power modules are classified as hazardous waste within the EU and must be removed and handled according to local regulations. For further information on environmental aspects and more detailed recycling instructions, please contact your local ANCA Motion distributor.

10.8 Standards Conformity

Information regarding the AMD5x PIU and Drives standards conformity is shown in *Table 43.*

Table 43: AMD5x PIU and Drive Standards Conformity

Marking & Applicable Regulations	Standard	Certification Organisation	PIU	Drives
CE LVD 2014/35/EU (Low Voltage Directive) EMC 2014/30/EU (Electromagnetic Compatibility)	EN 61800-5-1: 2007 (Class I) EN 61800-3:2017 (Category C3) Emissions: CISPR 11:2015/A1:2016 CISPR 22:2008.09 IEC 61000-3-11:2011 IEC 61000-3-12:2011 Immunity: IEC 61000-4-2:2008 IEC 61000-4-3 :2006/A2:2010 IEC 61000-4-4:2012 IEC 61000-4-5:2014 IEC 61000-4-6:2013 IEC 61000-2-1:1990 IEC 61000-2-4:2003 IEC 60146-1-1:1993	Precision Machinery Research and Development Centre Taichung. Taiwan EMC Bayswater Pty Ltd. Taichung, Taiwan	✓	✓
FC	FCC Part 15 Standards: FCC CFR Title 47 Part 15 Subpart B: 2005 Class A (Radiated and Conducted Emission)	Precision Machinery Research and Development Centre Taichung, Taiwan	✓	✓
EtherCAT[7]	ETG 1000 series ETG 9001 ETG 1300	Note: the AMD5x is a conforming EtherCAT device, but does not qualify as conformance tested. ANCA Motion self-determination of compliance.	✓	✓
Those items in the drive with no applicable regulation, but to which standards have been applied.	Servo Profile over EtherCAT fieldbus profile (SoE). IEC 61800-7. IEC 61491, for serial data link real time communications in industrial machines.	ANCA Motion self-determination of compliance within certain limits.	✓	✓

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

10.8.1 **EtherCAT Conformance Marking**

An EtherCAT device conformance mark is attached to each drive in order to verify that the unit has been tested for compliance with the EtherCAT marking, indicator and performance guidelines covered by the ETG standards listed in section 10.8. Future drive revisions intend to achieve “Conformance tested” marking by independent verification through an externally registered body.

10.8.2 **CE Marking**

A CE mark is attached to each drive in order to verify that products meets the relevant Low Voltage and Electromagnetic Compliance (EMC) directives of the European Union.

10.8.2.1 European EMC Directive EN 61800-3

The object of this standard (61800-3) is to define the limits and test methods for a Power Drive System (PDS) according to its intended use, whether residential, commercial or industrial. The standard sets out immunity requirements and requirements for electromagnetic emissions as minimums within these different environments. The AMD5x PIUs and Drives are intended for use as Category 3 PDS, and have been tested and certified to comply for use within what 61800-3 defines as the second environment. The AMD5x PIUs and Drives comply with the standard with the following provisions:

1. The motor and control cables are selected according the specifications given in this manual.
2. The PIUs and Drives are installed and maintained according to the instructions given in this manual.
3. The maximum cable lengths are 30 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

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.

10.8.2.2 European Low Voltage Directive EN 61800-5-1

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 AMD5x PIUs and Drives are considered to be protective Class I PDS, and comply with the standard with the following provisions:

1. The PIU and Drives are installed and maintained according to the instructions given in this manual.

Definitions

Protective Class I

Equipment in which protection against electric shock does not rely on basic insulation only, but which includes an additional safety precaution in such a way that means are provided for the connection of accessible conductive parts to the protective (earthing) conductor in the fixed wiring of the installation, so that accessible conductive parts cannot become live in the event of a failure in the basic insulation.

10.8.2.3 European Low Voltage Directive EN 61000-3-12

The object of this standard (61000-3-12) is define the limits and test methods for a Power Drive System (PDS) according to its intended use, whether residential, commercial or industrial. The standard defines limits for voltage disturbances and harmonics produced by the PDS, and the methods for ascertaining compliance to the limits in order to maintain electromagnetic compatibility within the electrical network. The AMD5x PIU and drive comply with the standard with the following provisions:

1. The PIU and Drives are installed and maintained according to the instructions given in this manual.
2. The PIU and Drives are installed with a line inductor as defined by *Table 24: Recommended EMC components for a 380-480V L-L 3 Phase supply.*
3. The PIU and Drives are installed in an environment where the mains supply $R_{sce} \geq 350$
4. The PIU is operated at rated load. *Consult ANCA Motion* for compliance at loads less than rated.

Definitions

R_{sce} Short circuit ratio. The ratio of the short circuit power of the source at a defined PCC (S_{sc}), to the rated power of the equipment (S_{equ}) .
$R_{sce} = S_{sc} / S_{equ}$

10.8.3 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.

All AMD5x PIUs and 20A, 12A, 6A , 3A drive variants, and capacitor modules are FCC compliant.

11 Accessories

11.1 What This Chapter Contains

This chapter contains information on accessories options available for the AMD5x system.

For additional details, please refer to *12.3 Product, Sales and Service Enquiries*

11.2 EMI Filter

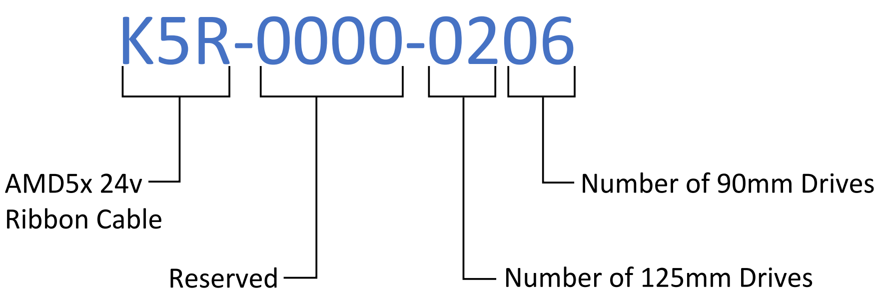
ANCA Part Number	Description
ICN-3096-0036	Schaffner 30A RFI filter. FN 3258-30-33

11.3 Line Reactor

ANCA Part Number	Description
ICN-3101-0116	TDK 30A, 1mH Reactor. B86305L0030R000

11.4 24 Vdc Ribbon Cable

Product code



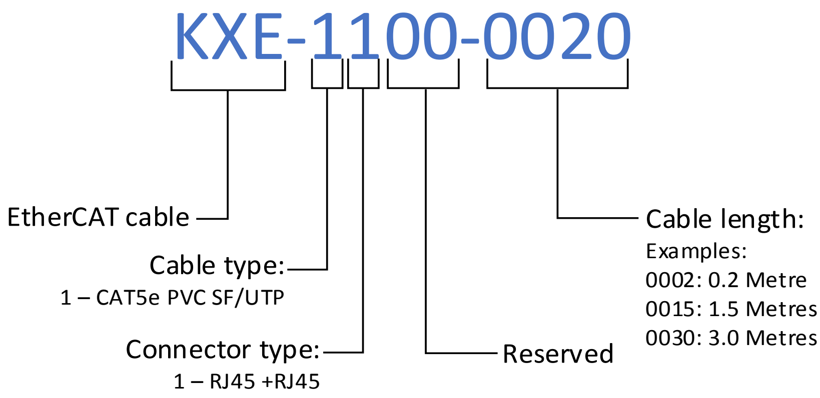
Examples

Table 44: 24 Vdc Ribbon Cables Examples	
ANCA Part Number	**Description**
K5R-0000-0006	24 Vdc Ribbon Cable to suit PIU + Drives configuration: PIU + 6x90mm Drives
K5R-0000-0204	24 Vdc Ribbon Cable to suit PIU + Drives configuration: PIU + 2x125mm Drives + 4x90mm Drives
K5R-0000-0205	24 Vdc Ribbon Cable to suit PIU + Drives configuration: PIU + 2x125mm Drives + 5x90mm Drives
K5R-0000-0206	24 Vdc Ribbon Cable to suit PIU + Drives configuration: PIU + 2x125mm Drives + 6x90mm Drives

For other AMD5x PIU and Drive combinations, please refer to *12.3 Product, Sales and Service Enquiries*

11.5 EtherCAT® Cables

Product code



Examples

Table 45: EtherCAT® Cable Examples	
Catalogue Number	**Description**
KXE-1100-0002	Ethernet Cable, Cat 5e, SF/UTP, 0.2m
KXE-1100-0015	Ethernet Cable, Cat 5e, SF/UTP, 1.5m
KXE-1100-0030	Ethernet Cable, Cat 5e, SF/UTP, 3.0m

For additional details, please refer to *12.3 Product, Sales and Service Enquiries*

11.6 Cooling Duct Fan Kit

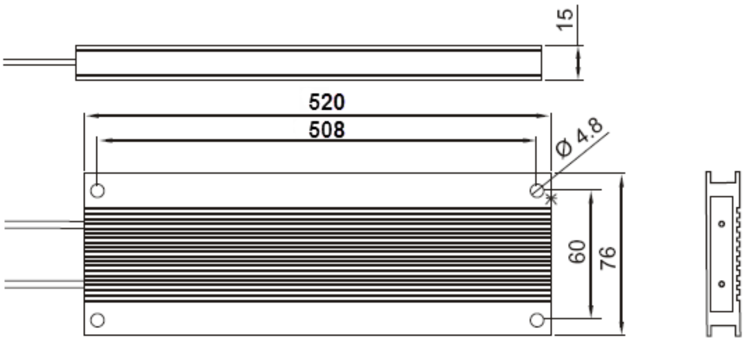
Table 46: Cooling Duct Fan Kits	
ANCA Part Number	**Description**
619-0-00-1733	AMD5x Fan Module kit Includes: 2 x fans with mounting screws; 4 x finger guards. Fan Rating: 114mA @ 24 V. Fan Connection: Red=+24 V, Blue=0V.
619-0-00-1770	AMD5x High Speed Fan Module kit Includes: 2 x High speed fans with mounting screws; 4 x finger guards. Fan Rating: 283mA @ 24 V. Fan Connection: Red=+24 V, Blue=0V, White=Tach output, Purple=0-10V/PWM input

For correct fan kit selection, please refer to *12.3 Product, Sales and Service Enquiries*

11.7 Regen Resistor

11.7.1 Regen Resistor

ANCA Part Number	Description
ICN-3009-0317	Aluminium Housed Braking Resistor, 36Ω ± 10%, 500W (with heatsink), 300W (without heatsink),18kW for 1s

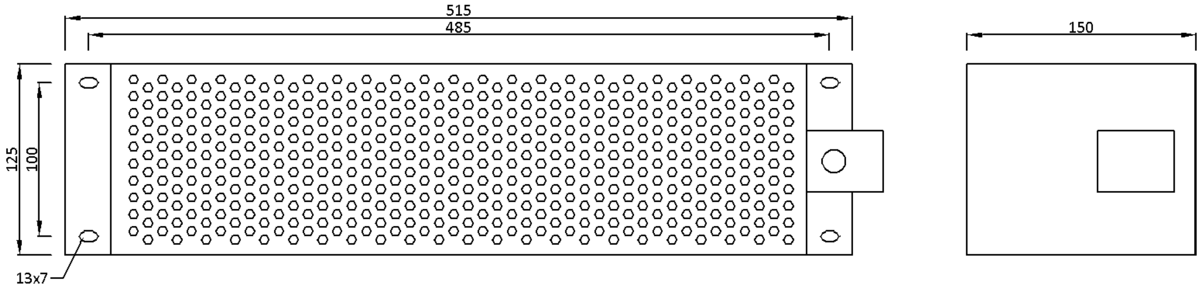


11.7.2 Regen Resistor Over-Temperature Switch

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

11.7.3 Regen Resistor with Enclosure and Over-Temperature Switch

ANCA Part Number	Description
ICN-3009-0850	Aluminium Housed Braking Resistor, 36Ω ± 10%, 375W 180°C temperature switch, 24kW 1s.



11.8 Cables

11.8.1 Shielded Encoder Cable Beta/Gamma Motors

Table 47: Shieled Encoder Cables for Beta Motors	
Catalogue Number	**Length**
K5B-FSMD-020	2m
K5B-FSMD-030	3m
K5B-FSMD-050	5m
K5B-FSMD-100	10m

11.8.2 Shielded Armature Cable for Beta/Gamma Motors

Table 48: Shielded Armature Cables for Beta Motors	
Catalogue Number	**Length**
K5B-ASMD-020	2m
K5B-ASMD-030	3m
K5B-ASMD-050	5m
K5B-ASMD-100	10m

11.8.3 Shielded Armature Cable for Beta/Gamma Motors with Thermal Sensor

Table 49: Shielded Armature Cables for Beta Motors with Thermal Sensor	
Catalogue Number	**Length**
K5B-TSMD-020	2m
K5B-T2ND-050	5m
K5B-T2ND-100	10m

11.8.4 Shielded Armature Cables for Beta/Gamma Motors with Brake

Table 50: Shielded Armature Cables for Beta Motors with Brake	
Catalogue Number	**Length**
K5B-BSMD-020	2m
K5B-BSMD-100	10m

11.8.5 Shielded Armature Cables for Beta/Gamma Motors with Brake and Thermal Sensor

Table 51: Shielded Armature Cables for Beta Motors with Brake and Thermal Sensor	
Catalogue Number	**Length**
K5B-SSMD-020	2m
K5B-SSMD-100	10m

11.8.6 Shielded Hiperface DSL Armature Cables for Gamma Motors with Brake

Table 52: Shielded Hiperface DSL Armature Cables for Gamma Motors with Brake	
Catalogue Number	**Length**
K5B-HSMD-020	2m
K5B-HSMD-300	30m

11.8.7 Shielded Hiperface DSL Armature Cables for Gamma Motors

Table 53: Shielded Hiperface DSL Armature Cables for Gamma Motors	
Catalogue Number	**Length**
K5B-DSMD-020	2m
K5B-DSMD-300	30m

11.8.8 Shielded Armature Cables for LinX M motor with Temperature

Table 54: Shielded Armature Cables for LinX M Motors with Temperature Sensor	
Catalogue Number	**Length**
K5M-T1MD-020	2m
K5M-T1MD-300	30m

11.8.9 Motor Power Cable Shield Clamps

Table 55: Motor Power Cable Shield Clamps	
ANCA Part Number	**Description**
ICN-3049-0522	Hebotec part SKDZ4 7-18 (for cable shield diameters 7-18 mm)
ICN-3049-0523	Hebotec part SKDZ4 3-12 (for cable shield diameters 3-12 mm)

Note: Cable shield diameter is typically 2mm less than cable Outer Diameter.

11.9 PIU and Drive Connectors

Table 56: PIU and Drive Connectors		
Catalogue Number	Description	Chapter Reference
ICN-3077-1670	15kW and 24kW PIU Regen Connector 2-Way	3.6.1 X1 – Regenerative Brake Resistor
ICN-3077-1252	15kW and 24kW PIU Power Supply Connector 4-Way	3.6.2 X2 – 3 Phase Mains + Earth Supply
ICN-3077-0875	15kW & 24kW PIU Regen Over-Temperature Connector 2-Way	3.6.3 X5 – Regenerative Brake Resistor Over-Temperature Switch
ICN-3077-1669	15kW and 24kW PIU 24 Vdc Connector 2-Way	3.6.5 X7 – 24 Vdc Supply
ICN-3077-0896	Drive Brake Connector 4-Way	3.7.1 X10 – 24 Vdc Brake Connections
ICN-3077-1675	3A, 6A, 12A & 20A Drive Armature Connector 4-Way	3.7.2 X11 – 3 Phase Armature Supply
ICN-3077-1732	35A and 35AH Drive Armature Connector 4-Way	3.7.2 X11 – 3 Phase Armature Supply
ICN-3077-0875	Drive Motor Temperature Sensor Connector 2-Way	3.7.3 X12 – Motor Temperature Sensor Input
ICN-3077-1982	Drive Encoder Connector 2-Way	3.7.9 X30 – Hiperface DSL Encoder Interface
ICN-3077-1898	Drive IO Interface Connector 12-Way (two Connectors required)	3.7.11 X31 BiSS Encoder Functional Safety Outputput

11.10 Fan Replacement Kit for Wall and Recessed Mount

Table 57: Fan Housing Kit for Wall and Recessed Mount	
Part Number	Description
619-0-00-2186	Fan Replacement kit for 15kW and 24kW PIU
619-0-00-2187	Fan Replacement kit for 35A and 35AH Drives
619-0-00-2188	Fan Replacement kit for 20A Drive
619-0-00-2189	Fan Replacement kit for 3A, 6A, and 12A Drives

12 Additional Information

12.1 What This Chapter Contains

This chapter contains information on product support and feedback:

- Maintenance and repairs
- Contact information
- Feedback on the 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 DC Bus voltage must be checked with a tested measuring instrument by trained and qualified personnel, prior to disconnecting the internal DC Bus bars.

There are no user serviceable parts inside the AMD5x drive or PIU; therefore maintenance only involves inspection of the drive its connections and enclosure. Make sure that all connections are fitted correctly and that there are no signs of damage. Check that all wires are tightly fitted to the connectors and that there are no signs of discolouration which may indicate heating. Make sure all drive covers are securely fitted and that they have no signs of damage. Make sure that the drive enclosure is free from dust or anything that may inhibit its operation. Refer to section *4 Mechanical Installation* for site requirements, tools, and installation and uninstallation information.

There are no internal adjustments inside the AMD5x. For any repairs please contact our nearest office or agent. Refer to section *12.3 Product, Sales and Service Enquiries.*

12.3 Product, Sales and Service Enquiries

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

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12.4 Feedback

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