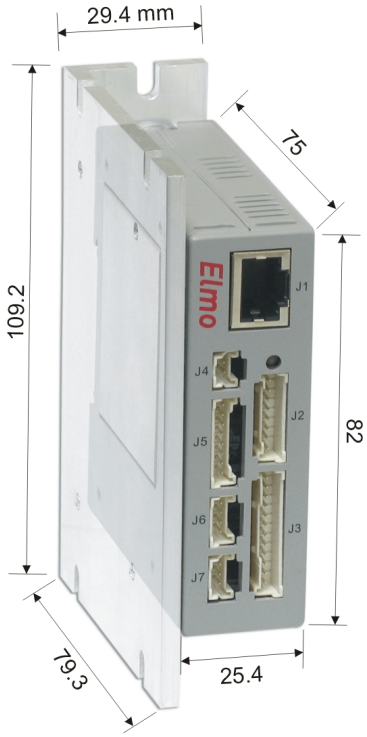
SimpIIQ Line

Harmonica
Digital Servo Drive
Installation Guide



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Elmo
Motion Control

www.elmomc.com

Notice

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- This guide contains proprietary information belonging to Elmo Motion Control Ltd. Such information is supplied solely for the purpose of assisting users of the Harmonica servo drive in its installation.
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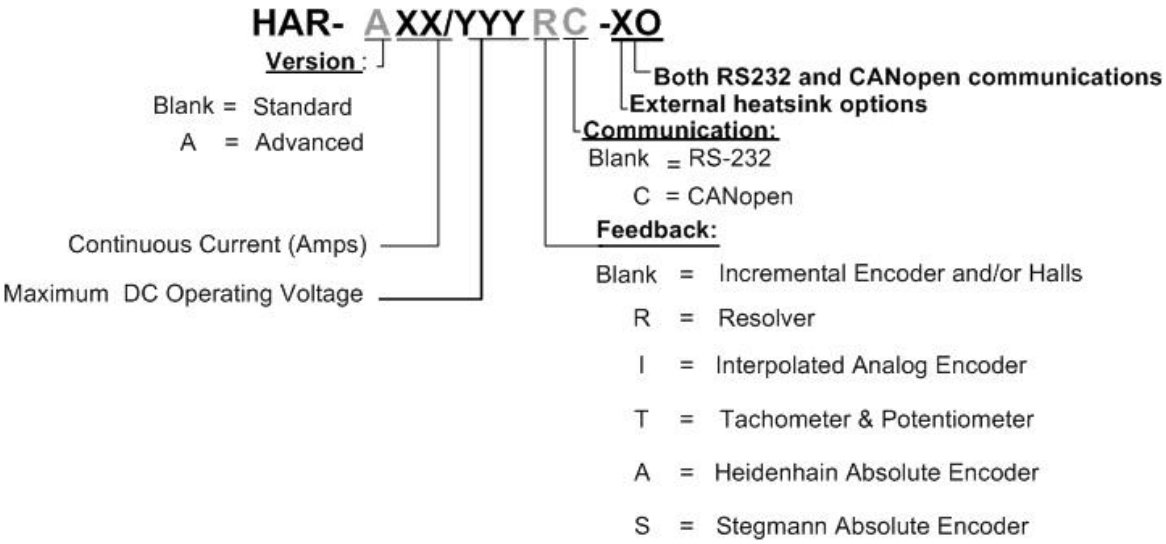
Document no. MAN-HARIG (Ver. 2.001)

Catalog Number



Cable Kit

- Catalog number: HAR-CABLEKIT (can be ordered separately)
- For further details, see the documentation for this cable kit (MAN-CBLKIT.pdf).

Revision History

Version		Details
1.0		Initial release
1.5	Apr 2008	Updated Power Ratings
1.6	Aug 2008	Updated Section 3.5.5.4: Differential pulse-and-direction input
1.7	Feb 2009	MTCR 00-100-36: Removed “Analog input command resolution” from Section 4.9.1
1.8	June 2009	Updated catalog number diagram on the Notice page (above) and in Section 3.2
1.9	July 2012	Formatted according to the new template
1.901	Feb 2013	Added a caution and recommendation on the type of cleaning solution to use for the Elmo unit.
1.902	July 2014	General format changes
2.000	Aug 2015	General format changes
2.001	Oct 2017	Updated warranty Information section 1.5 and updated the part number label in section 3.2

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Chapter 1: Safety Information

In order to achieve the optimum, safe operation of the Harmonica servo drive, it is imperative that you implement the safety procedures included in this installation guide. This information is provided to protect you and to keep your work area safe when operating the Harmonica and accompanying equipment.

Please read this chapter carefully before you begin the installation process.

Before you start, ensure that all system components are connected to earth ground. Electrical safety is provided through a low-resistance earth connection.

Only qualified personnel may install, adjust, maintain and repair the servo drive. A qualified person has the knowledge and authorization to perform tasks such as transporting, assembling, installing, commissioning and operating motors.

The Harmonica servo drive contains electrostatic-sensitive components that can be damaged if handled incorrectly. To prevent any electrostatic damage, avoid contact with highly insulating materials, such as plastic film and synthetic fabrics. Place the product on a conductive surface and ground yourself in order to discharge any possible static electricity build-up.

To avoid any potential hazards that may cause severe personal injury or damage to the product during operation, keep all covers and cabinet doors shut.

The following safety symbols are used in this manual:

Warning:
This information is needed to avoid a safety hazard, which might cause bodily injury.

Caution:
This information is necessary for preventing damage to the product or to other equipment.

1.1. Warnings

- To avoid electric arcing and hazards to personnel and electrical contacts, never connect/disconnect the servo drive while the power source is on.
- Power cables can carry a high voltage, even when the motor is not in motion. Disconnect the Harmonica from all voltage sources before it is opened for servicing.
- After shutting off the power and removing the power source from your equipment, wait at least 1 minute before touching or disconnecting parts of the equipment that are normally loaded with electrical charges (such as capacitors or contacts). Measuring the electrical contact points with a meter before touching the equipment is recommended.

1.2. Cautions

- The Harmonica servo drive contains hot surfaces and electrically-charged components during operation.
- The maximum DC power supply connected to the instrument must comply with the parameters outlined in this guide.
- The Harmonica can operate only through an isolated power source, using an isolated transformer and a rectifier circuit. Power to this device must be supplied by DC voltage, within the boundaries specified for the Harmonica. High voltages may damage the drive.

  The DC power supply voltage range is defined in table in Section 4.3.

  Safety margins must be considered in order to avoid activating the under- or over-voltage protection against line variations and/or voltage drop under load. The transformer should be able to deliver the required power to the drive (including peak power) without significant voltage drops (10% maximum). While driving high-inertia loads, the power supply circuit must be equipped with a shunt regulator; otherwise, the drive will be disabled whenever the capacitors are charged above the maximum voltage.
- Before switching on the Harmonica, verify that all safety precautions have been observed and that the installation procedures in this manual have been followed.
- Do not clean any of the Harmonica drive's soldering with solvent cleaning fluids of pH greater than 7 (8 to 14). The solvent corrodes the plastic cover causing cracks and eventual damage to the drive's PCBs.

  Elmo recommends using the cleaning fluid Vigon-EFM which is pH Neutral (7).

  For further technical information on this recommended cleaning fluid, select the link:

  http://www.zestron.com/fileadmin/zestron.com-usa/daten/electronics/Product_TI1s/TI1-VIGON_EFM-US.pdf

1.3. Directives and Standards

The Harmonica conforms to the following industry safety standards:

Safety Standard	Item
Approved **IEC/EN 61800-5-1, Safety**	Adjustable speed electrical power drive systems
Recognized **UL 508C**	Power Conversion Equipment
In compliance with **UL 840**	Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment
In compliance with **UL 60950-1** (formerly **UL 1950**)	Safety of Information Technology Equipment Including Electrical Business Equipment
In compliance with **EN 60204-1**	Low Voltage Directive 73/23/EEC

The Harmonica servo drive has been developed, produced, tested and documented in accordance with the relevant standards. Elmo Motion Control is not responsible for any deviation from the configuration and installation described in this documentation. Furthermore, Elmo is not responsible for the performance of new measurements or ensuring that regulatory requirements are met.

1.4. CE Marking Conformance

The Harmonica servo drive is intended for incorporation in a machine or end product. The actual end product must comply with all safety aspects of the relevant requirements of the European Safety of Machinery Directive 98/37/EC as amended, and with those of the most recent versions of standards **EN 60204-1** and **EN 292-2** at the least.

According to Annex III of Article 13 of Council Directive 93/68/EEC, amending Council Directive 73/23/EEC concerning electrical equipment designed for use within certain voltage limits, the Harmonica meets the provisions outlined in Council Directive 73/23/EEC. The party responsible for ensuring that the equipment meets the limits required by EMC regulations is the manufacturer of the end product.

1.5. Warranty Information

The products covered in this manual are warranted to be free of defects in material and workmanship and conform to the specifications stated either within this document or in the product catalog description. All Elmo drives are warranted for a period of 12 months from the date of shipment. No other warranties, expressed or implied — and including a warranty of merchantability and fitness for a particular purpose — extend beyond this warranty.

Chapter 2: Introduction

This installation guide describes the Harmonica servo drive and the steps for its wiring, installation and powering up. Following these guidelines ensures maximum functionality of the drive and the system to which it is connected.

2.1. Drive Description

The Harmonica is a powerful servo drive that operates in digital current, velocity, position and advanced position modes, in conjunction with a permanent-magnet synchronous brushless motor or DC brush motor. The Harmonica features flexible sinusoidal and trapezoidal commutation, with vector control. The Harmonica can operate as a stand-alone device or as part of a multi-axis network in a distributed configuration.

The Harmonica drive is set up and tuned using Elmo's Composer software. This Windows-based application enables users to quickly and simply configure the servo drive for optimal use with their motor.

The Harmonica power source is a 10 to 195 VDC nominal power line. A separate 24 VDC power supply serves as both the auxiliary supply *and* the backup supply. This allows a safe and economical "power backup" feature that is essential for positioning systems.

Two variations of the Harmonica are available: the *Standard* version and the *Advanced* version, which features advanced positioning capabilities. Both versions operate with RS-232 and/or CAN communication.

2.2. Product Features

2.2.1. Current Control

- Fully digital
- Sinusoidal commutation with vector control or trapezoidal commutation with encoder and/or digital Hall sensors
- 12-bit current loop resolution
- Automatic gain scheduling, to compensate for variations in the DC bus power supply

2.2.2. Velocity Control

- Fully digital
- Programmable PI and FFW (feed forward) control filters
- Sample rate two times current loop sample time
- "On-the-fly" gain scheduling
- Automatic, manual and advanced manual tuning and determination of optimal gain and phase margins

2.2.3. Position Control

- Programmable PIP control filter
- Programmable notch and low-pass filters
- Position follower mode for monitoring the motion of the slave axis relative to a master axis, via an auxiliary encoder input
- Pulse-and-direction inputs
- Sample time: four times that of current loop
- Fast event capturing inputs

2.2.4. Advanced Position Control *(Advanced model only)*

- Position-based and time-based ECAM mode that supports a non-linear follower mode, in which the motor tracks the master motion using an ECAM table stored in flash memory
- PT and PVT motion modes
- Dual (position/velocity) loop
- Fast output compare (OC)

2.2.5. Communication Options

Depending on the application, Harmonica users can select from two communication options:

- RS-232 serial communication
- CAN for fast communication in a multi-axis distributed environment

2.2.6. Feedback Options

- Incremental Encoder – up to 20 Mega-Counts (5 Mega-Pulse)
- Digital Halls – up to 2 kHz
- Incremental Encoder with Digital Halls for commutation – up to 20 Mega-Counts
- Absolute Encoder
- Interpolated Analog (Sine/Cosine) Encoder – up to 250 kHz
  - Internal Interpolation – programmable up to X4096
  - Automatic Correction of:
    - amplitude mismatch
    - phase mismatch
    - signals offset
  - Encoder outputs, buffered, differential
- Resolver
  - Programmable 10 to 15 bit resolution
  - Up to 512 revolutions per second (RPS)
  - Encoder outputs, buffered, differential

- Tachometer and Potentiometer
- Two inputs for Tachometer Feedback:
  - Up to ± 50 VDC
  - Up to ±20 VDC
- Potentiometer Feedback:
  - 0 to 5 V voltage range
  - Resistance: 100 Ω to 1000 Ω
- Elmo drives provide supply voltage for all the feedback options.

2.2.7. Fault Protection

The Harmonica includes built-in protection against possible fault conditions, including:

- Software error handling
- Status reporting for a large number of possible fault conditions
- Temperature protection feature with a threshold and tolerance, of 87 °C ± 3 °C
- Protection against conditions such as under/over voltage, loss of commutation signal, short circuits between the motor power outputs and between each output and power input/return
- Recovery from loss of commutation signals and from communication errors

2.3. System Architecture

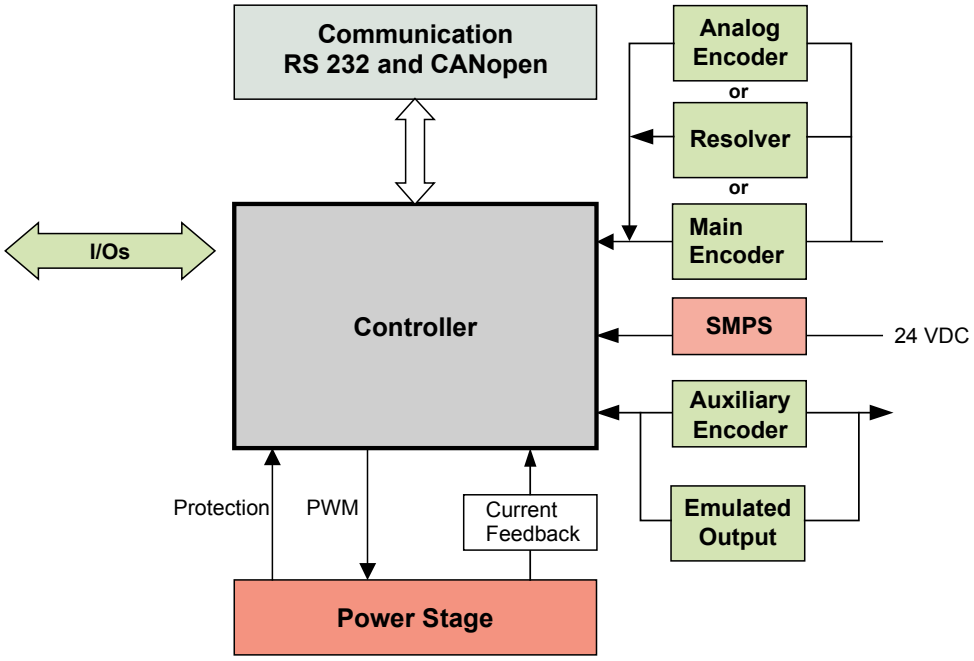


Figure 1: Harmonica System Block Diagram

2.4. How to Use this Guide

In order to install and operate your Elmo Harmonica servo drive, you will use this manual in conjunction with a set of Elmo documentation. Installation is your first step; after carefully reading the safety instructions in the first chapter, the following chapters provide you with installation instructions as follows:

- Chapter 3, *Installation*, provides step-by-step instructions for unpacking, mounting, connecting and powering up the Harmonica.
- Chapter 4, *Technical Specifications,* lists all the drive ratings and specifications.

Upon completing the instructions in this guide, your Harmonica servo drive should be successfully mounted and installed. From this stage, you need to consult higher-level Elmo documentation in order to set up and fine-tune the system for optimal operation. The following figure describes the accompanying documentation that you will require.

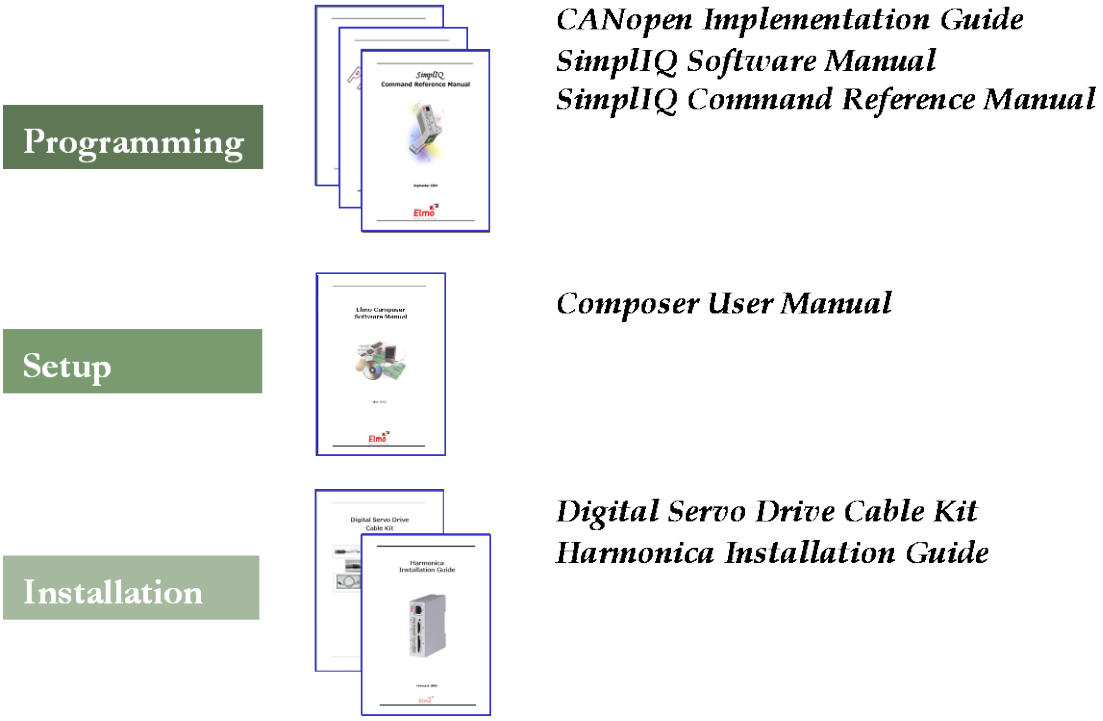


Figure 2: Elmo Documentation Hierarchy

As depicted in the previous figure, this installation guide is an integral part of the Harmonica documentation set, comprising:

- The Composer *Software Manual,* which includes explanations of all the software tools that are part of Elmo's Composer software environment.
- The *SimplIQ Command Reference Manual,* which describes, in detail, each software command used to manipulate the Harmonica motion controller.
- The *SimplIQ Software Manual,* which describes the comprehensive software used with the Harmonica.

Chapter 3: Installation

The Harmonica must be installed in a suitable environment and properly connected to its voltage supplies and the motor.

3.1. Before You Begin

3.1.1. Site Requirements

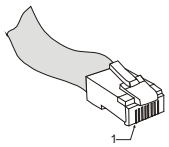
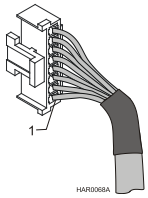
You can guarantee the safe operation of the Harmonica by ensuring that it is installed in an appropriate environment.

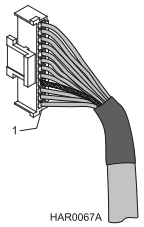
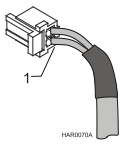
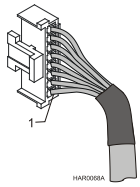
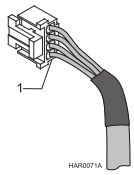
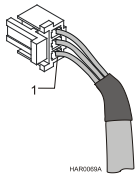
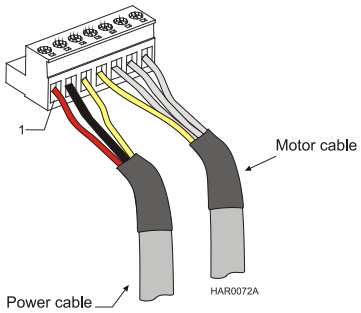
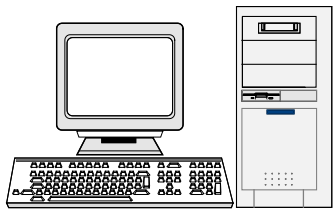
Feature	Value
Ambient operating temperature	0 °C to 40 °C (32 °F to 104 °F)
Maximum operating altitude	2,000 m (6562 feet)
Maximum relative humidity	90% non-condensing
Operating area atmosphere	No flammable gases or vapors permitted in area
Models for extended environmental conditions are available.	

Caution:
The Harmonica drive dissipates heat by convection. The maximum operating ambient temperature of 0 °C to 40 °C (32 °F to 104° F) must not be exceeded.

3.1.2. Hardware Requirements

The components that you will need to install your Harmonica are:

Component	Connector	Described in Section	Drawing
Communication cable (RS-232 or CAN)	**J1**	Page 33	
Auxiliary feedback cable (if needed)	**J2**	3.5.5.4	

Component	Connector	Described in Section	Drawing
Main feedback cable	**J3**	3.5.5.1	
Auxiliary power cable	**J4**	3.5.4	
Digital input cable (if needed)	**J5**	3.5.5.3.a	
Digital output cable (if needed)	**J6**	3.5.5.3.b	
Analog input cable (if needed)	**J7**	3.5.5.3.c	
Main power cable	**J8**	3.5.2.2	
Motor cable	**J8**	3.5.2.2	
PC for drive setup and tuning			

Component	Connector	Described in Section	Drawing
Motor data sheet or manual			

3.2. Unpacking the Drive Components

Before you begin working with the Harmonica system, verify that you have all of its components, as follows:

- The Harmonica servo drive
- The Composer software and software manual
- The Harmonica cable kit (if ordered separately)

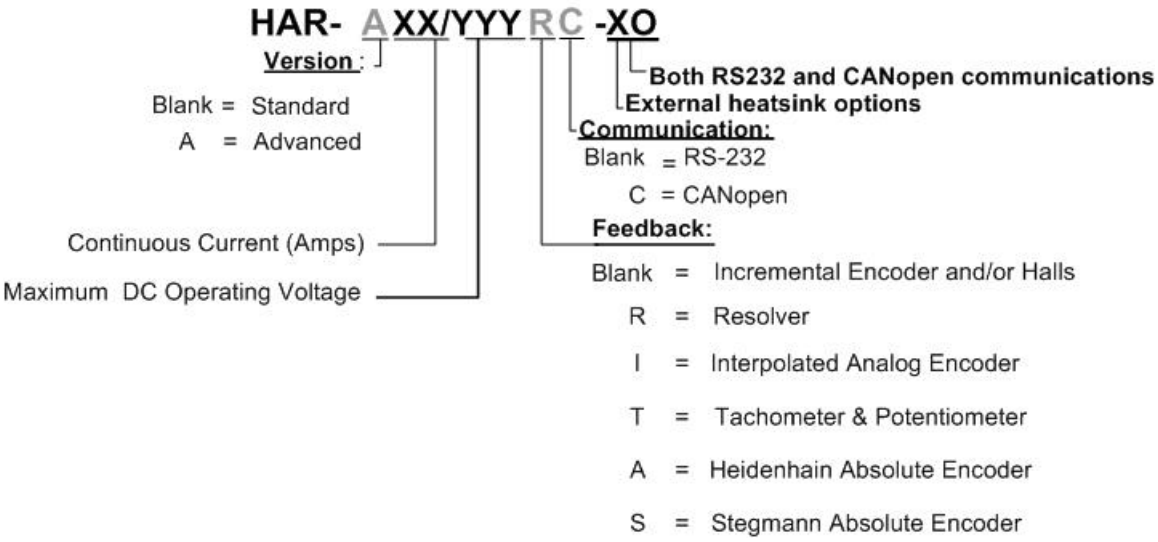
The Harmonica is shipped in a cardboard box with Styrofoam protection.

To unpack the Harmonica:

1. Carefully remove the servo drive from the box and the Styrofoam.
2. Check the drive to ensure that there is no visible damage to the instrument. If any damage has occurred, report it immediately to the carrier that delivered your drive.
3. To ensure that the Harmonica you have unpacked is the appropriate type for your requirements, locate the part number sticker on the side of the Harmonica. It looks like this:

HAR065B

The P/N number at the top gives the type designation as follows:



4. Verify that the Harmonica type is the one that you ordered, and ensure that the voltage meets your specific requirements.

3.3. Assembling the Heatsink

When an external heatsink device is required, attach it with four screws to the left side of the Harmonica, as depicted in the following diagrams.

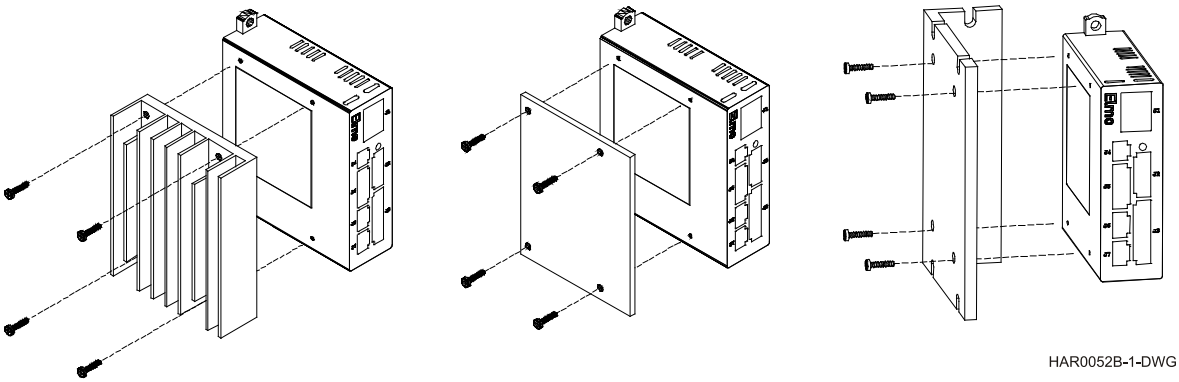


Figure 3: Attaching the Heatsink

To mount the heatsink, use screws designed for fastening to plastic with a 2.00 mm hole diameter and a maximum 7.5 mm depth (such as EJOT® PT® K50).

Detailed heatsink drawings can be found on page 63.

3.4. Mounting the Harmonica

The Harmonica has been designed for two standard mounting options:

- Mounting on a DIN rail
- Attaching directly to the wall with screws

3.4.1. Mounting on a DIN Rail

At the top rear of the Harmonica, a horizontal groove lets you quickly and easily snap the drive onto a DIN rail in your work area.

To mount the Harmonica on a DIN rail:

1. At the back of the Harmonica, push the bottom mounting strip down fully.
2. Tilt the Harmonica back towards the top part of the DIN rail.
3. Press the Harmonica down to a vertical position until it clicks onto the DIN rail.
4. Push the bottom mounting strip one notch up to lock the Harmonica on the rail.

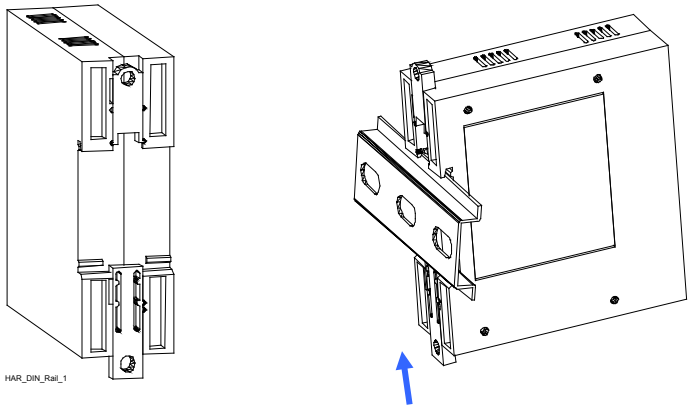


Figure 4: Mounting the Harmonica on a DIN Rail

3.4.2. Mounting Directly onto a Wall

The mounting strips at the back of the Harmonica enable you to screw the drive directly into a wall.

To mount the Harmonica onto a wall:

1. On the back of the drive, fully extend the top mounting strip so that the end with the holes is exposed. (The bottom strip is delivered already extended.)
2. Mount the Harmonica vertically onto the wall with two M3 or M3.5 round head screws, one through the top hole of the mounting strip and one at the bottom.

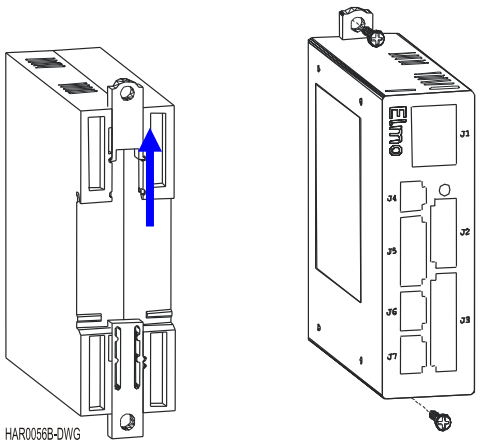


Figure 5: Extending the Mounting Strips and Attaching the Screws

3.5. Connecting the Cables

The Harmonica has eight connectors.

3.5.1. Wiring the Harmonica

Once the Harmonica is mounted, you are ready to wire the device. Proper wiring, grounding and shielding are essential for ensuring safe, immune and optimal servo performance of the Harmonica.

Caution:
Follow these instructions to ensure safe and proper wiring:

- Use twisted and shielded wires for control, feedback and communication cables. For best results, use an aluminum foil shield with copper braid.
- The impedance of the wire must be as low as possible. The size of the wire must be thicker than actually required by the carrying current. A 24, 26, 28 or 30 AWG wire for control and feedback cables is satisfactory.
- Use shielded wires for motor connections as well. If the wires are long, ensure that the capacitance between the wires is not too high: C < 30 nF is satisfactory for most applications.
- Keep all wires and cables as short as possible.
- Keep the motor wires as far away as possible from the feedback, control and communication cables.
- Ensure that in normal operating conditions, the shielded wires and drain *carry no current.* The only time these conductors carry current is under abnormal conditions, when electrical equipment has become a potential shock or fire hazard while conducting external EMI interferences directly to ground, in order to prevent them from affecting the drive. Failing to meet this requirement can result in drive/controller/host failure.
- After completing the wiring, carefully inspect all wires to ensure tightness, good solder joints and general safety.

The following connectors are used for wiring the Harmonica.

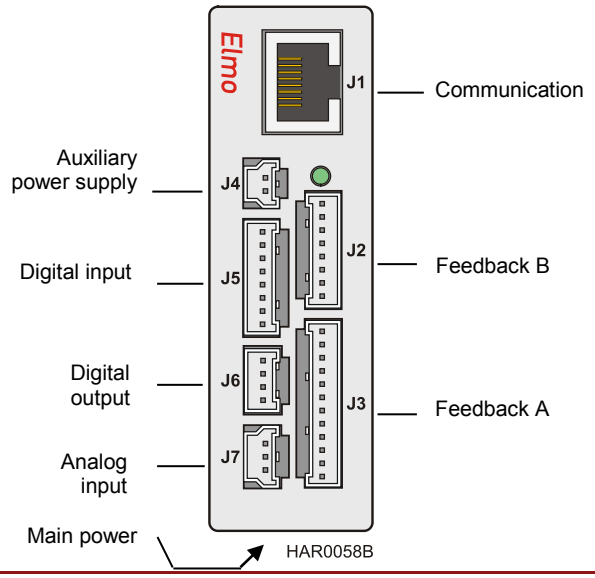
Type	Function	Port	Connector Locations
8-pin RJ-45	Communication (CAN or RS-232)	J1	
8-pin Molex	Feedback B	J2	
12-pin Molex	Feedback A	J3	
2-pin Molex	Auxiliary power supply	J4	
8-pin Molex	Digital input	J5	
4-pin Molex	Digital output	J6	
3-pin Molex	Analog input	J7	
7-pin Phoenix	Main power	J8	

Table 1: Harmonica Connectors

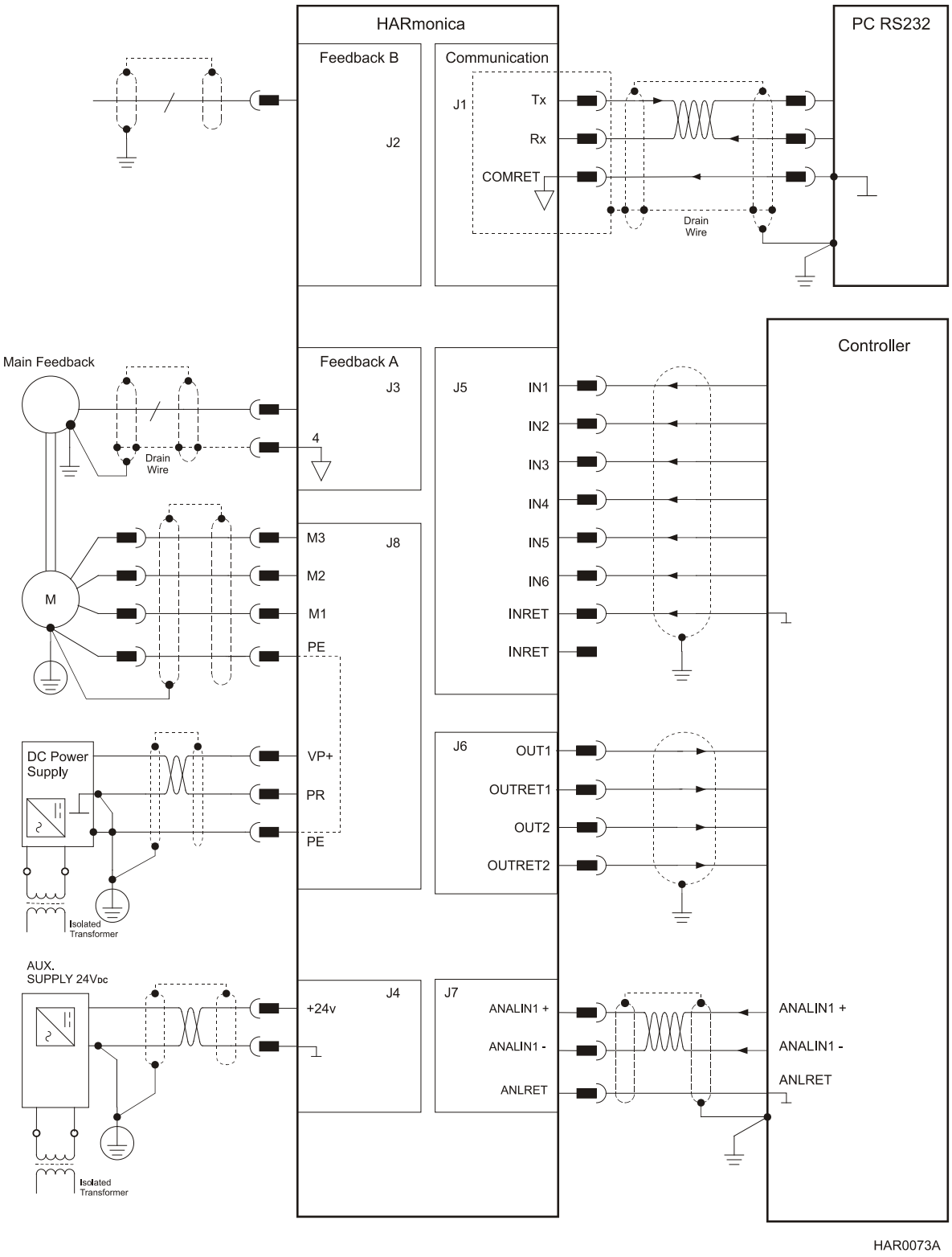


Figure 6: Harmonica Detailed Connection Diagram with RS-232 Communication Option

3.5.2. Connecting the Power Cables (J8)

The main power connector, which is located on the bottom of the Harmonica, includes the following pins:

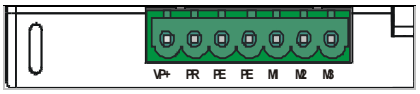
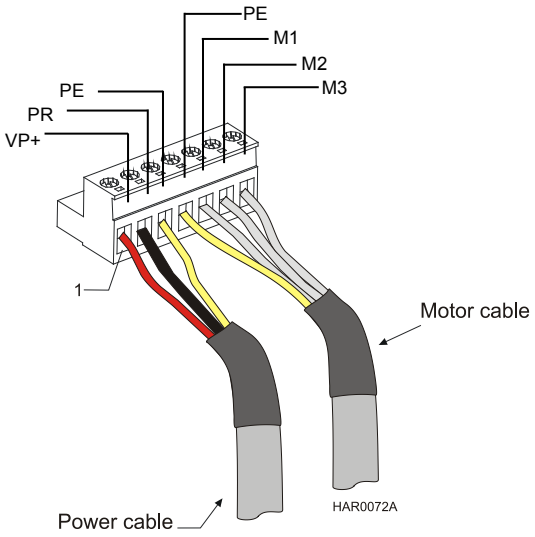
<table>
<tr><th>Pin</th><th>Function</th><th colspan="2">Cable</th><th>Pin Positions</th></tr>
<tr><td>VP+</td><td>Power input, positive</td><td colspan="2">Power</td><td rowspan="2"> 
</td></tr>
<tr><td>PR</td><td>Power input, common</td><td colspan="2">Power</td></tr>
<tr><td>PE</td><td>Protective earth</td><td colspan="2">Power</td><td rowspan="8"> 
</td></tr>
<tr><td></td><td></td><td>AC Motor Cable</td><td>DC Motor Cable</td></tr>
<tr><td>PE</td><td>Protective earth</td><td>Motor</td><td>Motor</td></tr>
<tr><td>M1</td><td>Motor phase</td><td>Motor</td><td>N/C</td></tr>
<tr><td>M2</td><td>Motor phase</td><td>Motor</td><td>Motor</td></tr>
<tr><td>M3</td><td>Motor phase</td><td>Motor</td><td>Motor</td></tr>
<tr><td colspan="4">Note: When connecting several motors, all must be wired in an identical manner.</td></tr>
</table>

Table 2: Connector for Main Power and Motor Cables

3.5.2.1. Connecting the Motor Cable

Connect the motor power cable to the M1, M2, M3 and PE terminals of the main power connector. The phase connection order is arbitrary because the Composer will establish the proper commutation automatically during setup.

Notes for connecting the motor cables:

- For best immunity, it is highly recommended to use a shielded (not twisted) cable for the motor connection. A 4-wire shielded cable should be used. The gauge is determined by the actual current consumption of the motor.
- Connect the shield of the cable to the closest ground connection at the motor end.
- The fourth wire should be used for the ground connection between the motor and the second PE terminal of the Harmonica.
- Be sure that the motor chassis is properly grounded.

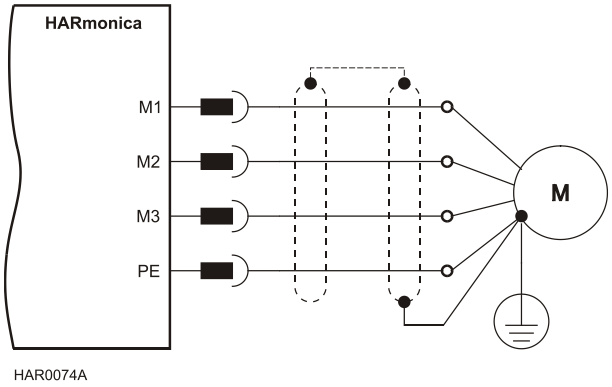


Figure 7: AC Motor Power Connection Diagram

3.5.2.2. Connecting the Main Power Cable

Connect the main power supply cable to the VP+ and PR terminals of the main power connector.

Notes for connecting the DC power supply:

- Be sure to isolate the source of the DC power supply.
- For best immunity, it is highly recommended to use twisted cables for the DC power supply cable. A 3-wire shielded cable should be used. The gauge is determined by the actual current consumption of the motor.
- Connect the cable shield to the closest ground connection near the power supply.
- Connect the PE to the closest ground connection near the power supply.
- Connect the PR to the closest ground connection near the power supply.

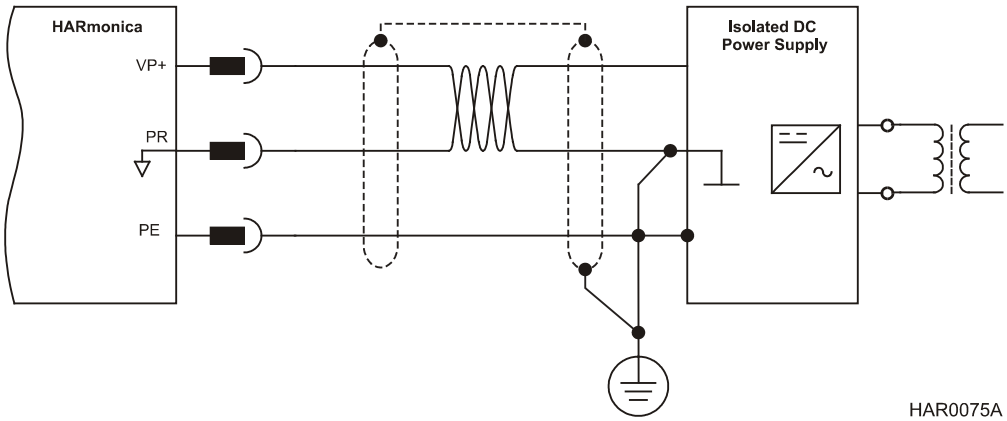


Figure 8: Main Power Supply Connection Diagram

3.5.3. Special Note about Disconnecting Molex Connectors

The Auxiliary Power Cable (J4), the Feedback cables (J2 and J3) and the I/O cables (J5, J6 and J7) all use 2 mm pitch Molex connectors. These connectors snap together quite easily, but require a small standard screwdriver for disassembly.

To disassemble the Molex connector:

1. Slip the screwdriver into the lock: The lock disengages.
2. Twist the screwdriver downward with light pressure on the handle (see the figure below).

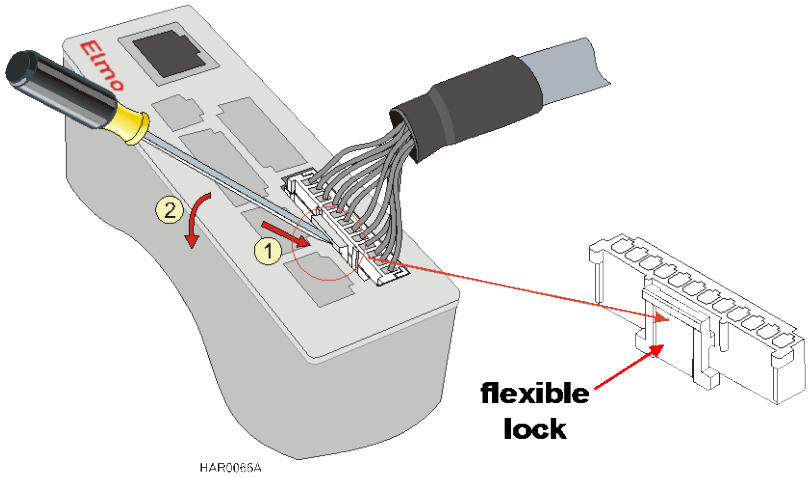


Figure 9: Disconnecting Molex Connectors

3.5.4. Connecting the Auxiliary Power Cable (J4)

Connect the auxiliary power supply to the J4 port on the front of the Harmonica, using a 2-pin Molex plug. *Remember, you are working with DC power; be sure to exercise caution.* The required voltage is 24 VDC.

Notes for 24 VDC auxiliary power supply connections:

- Use a 24, 26 or 28 AWG twisted pair shielded cable. The shield should have copper braid.
- The source of the 24 VDC must be isolated.
- For safety reasons, connect the return (common) of the 24 VDC source to the closest ground.
- Connect the cable shield to the closest ground near the 24 VDC source.
- Before applying power, first verify the polarity of the connection.

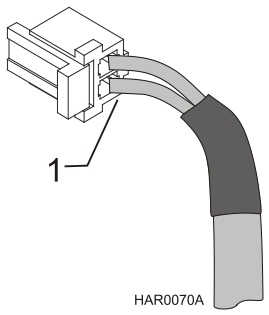
Pin	Signal	Function	Pin Positions
1	+24 VDC	+24 VDC auxiliary power supply	
2	RET24VDC	Return (common) of the 24 VDC auxiliary power supply	

Table 3: Auxiliary Power Cable Plug

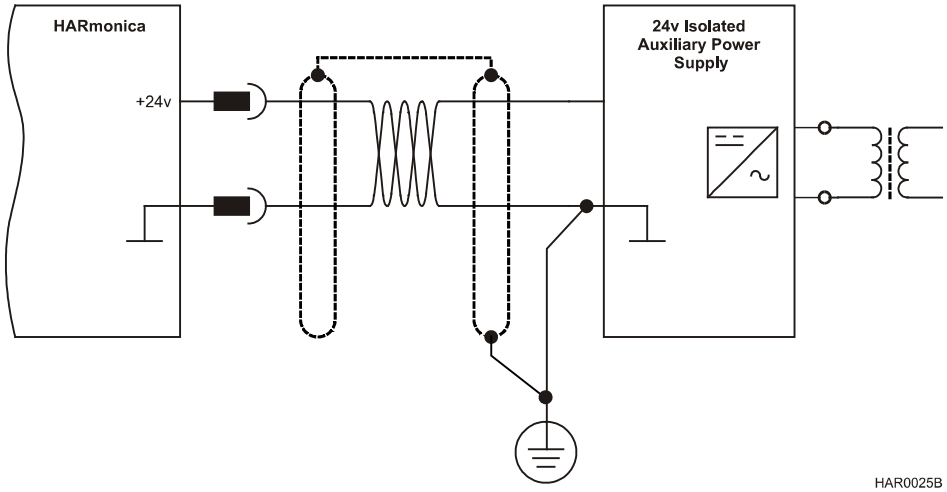


Figure 10: Auxiliary Power Supply (J4) Connection Diagram

3.5.5. Connecting the Feedback and Control Cables

The Harmonica features easy-to-use connections for all required cables. These connections support several types of configurations and interfaces.

3.5.5.1. Main Feedback (Feedback A) Cable (Port J3)

The main feedback cable is used to transfer feedback data from the motor to the drive.

The Harmonica accepts the following as a main feedback mechanism:

- Incremental encoder only
- Incremental encoder with digital Hall sensors
- Digital Hall sensors only
- Incremental Analog (Sine/Cosine) encoder (option)
- Resolver (option)
- Tachometer and Potentiometer
- Absolute encoder

Connect the main feedback cable from the motor to the J3 port on the front of the Harmonica, using a 12-pin, Molex plug.

Notes for connecting the J3 cable:

- Use 24 or 26 AWG twisted-pair shielded cables. For best results, the shield should have aluminum foil covered by copper braid.
- Connect the drain wire to pin 4.

  The drain wire is a non-insulated wire that is in contact with parts of the cable, usually the shield. It is used to terminate the shield and as a grounding connection.
- Ground the shield to the motor chassis (except on resolver cables).

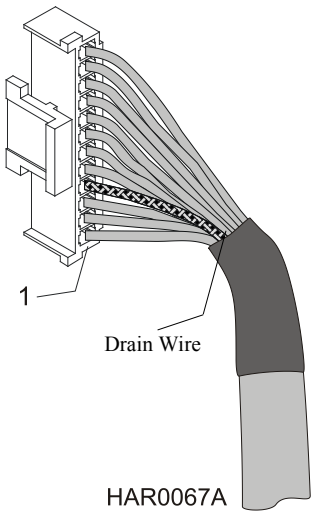


Figure 11: The Feedback (J3) Cable

	Incremental Encoder		Interpolated Analog (Sine/Cosine) Encoder		Resolver		Tachometer and Potentiometer	
	HAR-XX/YYY_		HAR-XX/YYYI		HAR-XX/YYYR		HAR-XX/YYYT	
Pin (J3)	Signal	Function	Signal	Function	Signal	Function	Signal	Function
1	HC	Hall sensor C input	HC	Hall sensor C input	NC	-	HC	Hall sensor C input
2	HB	Hall sensor B input	HB	Hall sensor B input	NC	-	HB	Hall sensor B input
3	HA	Hall sensor A input	HA	Hall sensor A input	NC	-	HA	Hall sensor A input
4	SUPRET	Supply return	SUPRET	Supply return	SUPRET	Supply return	SUPRET	Supply return
5	SUPRET	Supply return	SUPRET	Supply return	SUPRET	Supply return	SUPRET	Supply return
6	+5V	Encoder/Hall +5 V supply voltage, 5 V @ 200 mA maximum	+5V	Encoder/Hall +5 V supply voltage, 5 V @ 200 mA maximum	NC	-	+5V	Encoder/Hall +5 V supply voltage

	Incremental Encoder		Interpolated Analog (Sine/Cosine) Encoder		Resolver		Tachometer and Potentiometer	
7	INDEX-	Index complement	R-	Reference complement	R2	Vref complement Vref 3.5RMS S = 1/TS, 50 mA Max.	NC	-
8	INDEX	Index	R+	Reference	R1	Vref 3.5 vrms, S=1/TS, 50 mA	POT	Potentiometer Input
9	CHB-	Channel B complement	B-	Cosine B complement	S4	Cosine B complement	Tac 2-	Tacho Input 2 Neg. (50 V max)
10	CHB	Channel B	B+	Cosine B	S2	Cosine B	Tac 2+	Tacho Input 2 Pos. (50 V max)
11	CHA-	Channel A complement	A-	Sine A complement	S3	Sine A complement	Tac 1-	Tacho Input 1 Neg. (20 V max)
12	CHA	Channel A	A+	Sin A	S1	Sin A	Tac 1+	Tacho Input 1 Pos. (20 V max)

Table 4: Main Feedback Cable Pin Assignments (Part A)

	EnDat (Heidenhain) Absolute Encoder		Stegmann Absolute Encoder	
	HAR-XX/YYYA		HAR-XX/YYYS	
Pin	Signal	Function	Signal	Function
1	CLK -	CLOCK complement	HC	-
2	CLK +	CLOCK	HB	-
3	HA	-	HA	-
4	SUPRET	Supply return	SUPRET	Supply return
5	SUPRET	Supply return	SUPRET	Supply return
6	+5V	Encoder +5 V supply voltage, 5 V @ 200 mA maximum	+8V	Encoder +8 V supply voltage, 8 V @ 90 mA maximum
7	DATA -	Data complement	DATA -	Data complement
8	DATA +	DATA	DATA +	DATA
9	B -	Cos B complement	B -	Cos B complement
10	B +	Cos B	B +	Cos B
11	A -	Sine A complement	A -	Sin A
12	A +	Sine A	A +	Sine A complement

Table 5: Main Feedback Cable Pin Assignments (Part B)

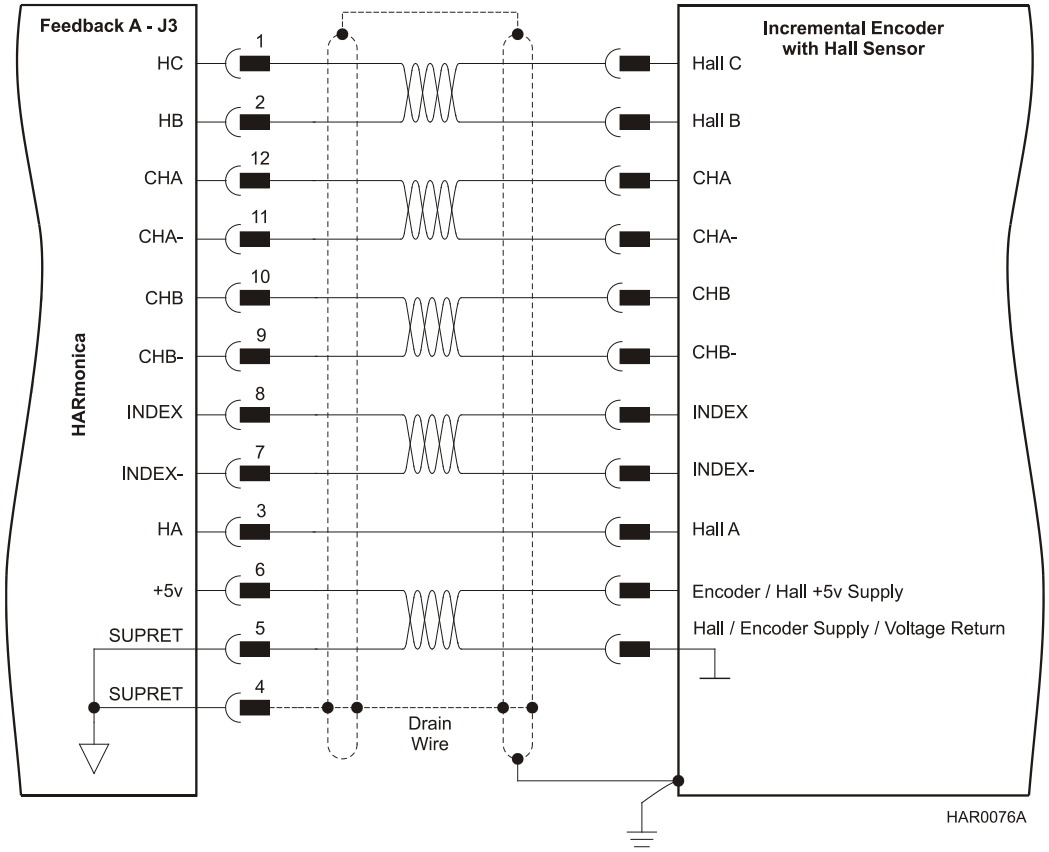


Figure 12: Main Feedback - Incremental Encoder Connection Diagram

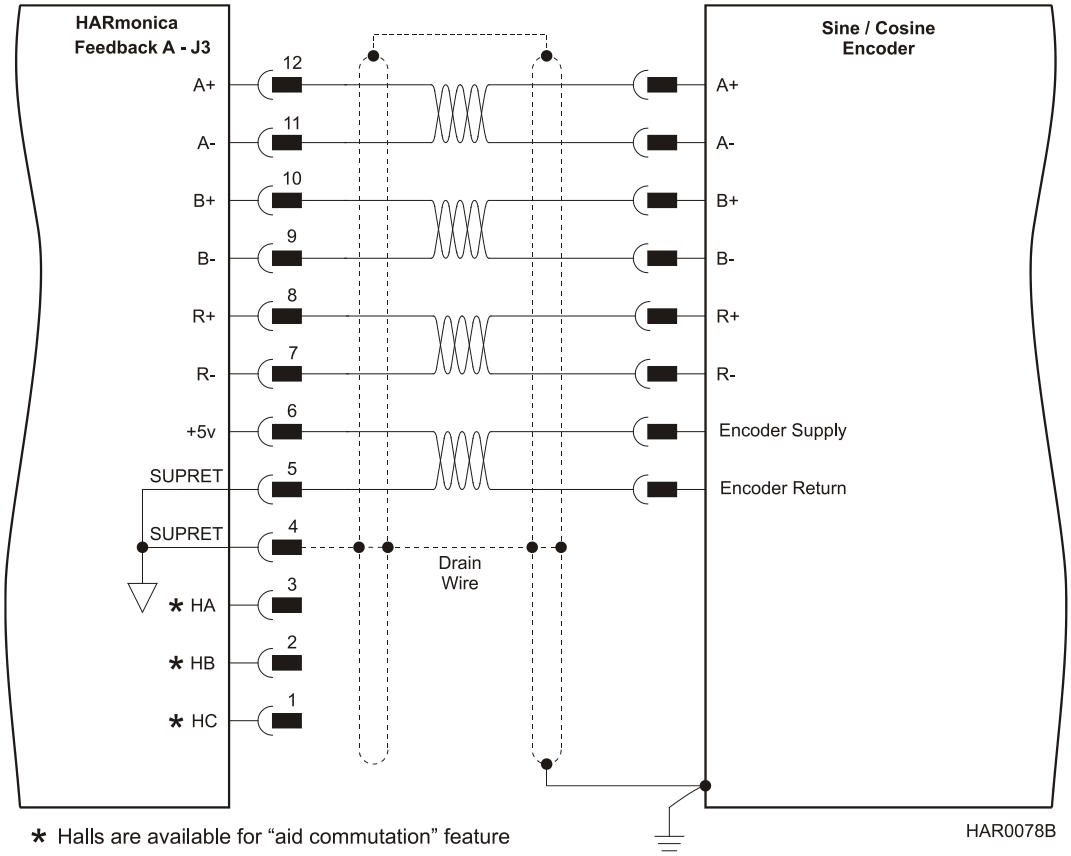


Figure 13: Main Feedback – Interpolated Analog (Sine/Cosine) Encoder Connection Diagram

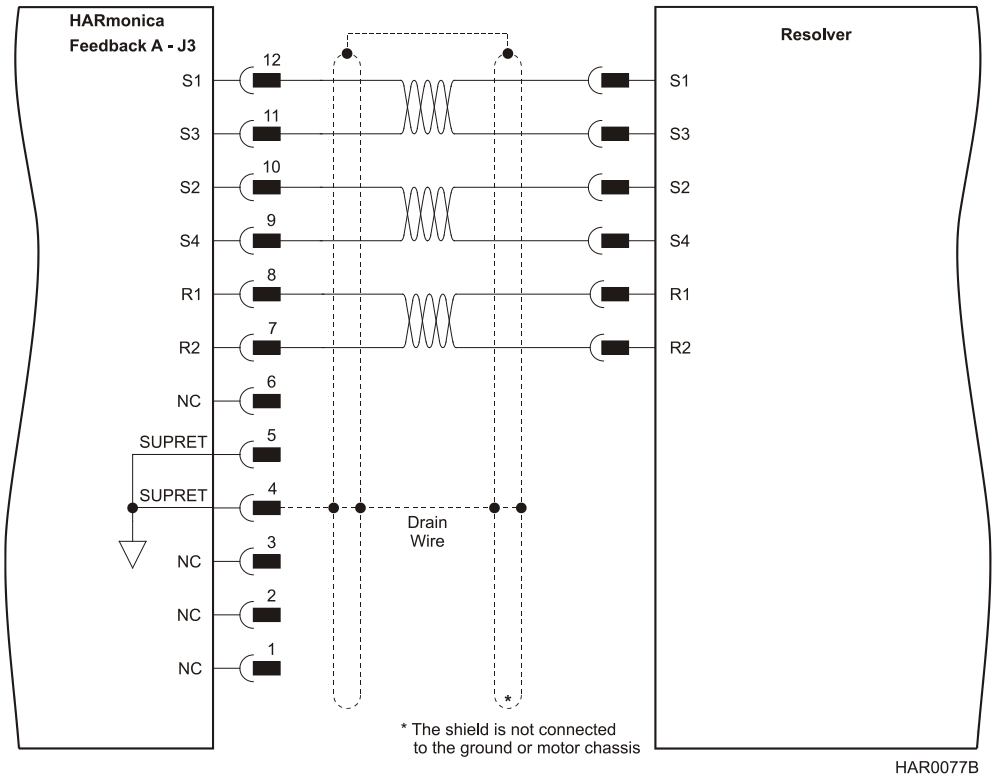


Figure 14: Main Feedback – Resolver Connection Diagram

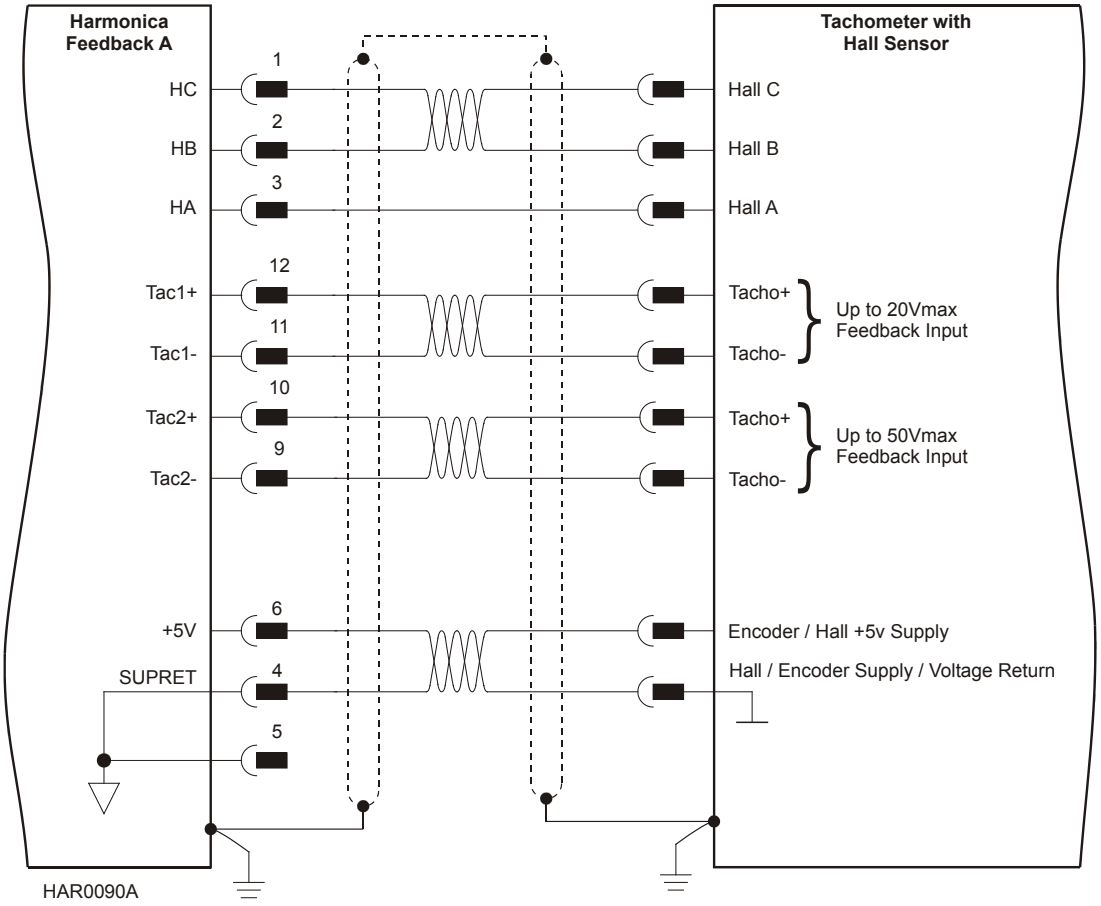


Figure 15: Main Feedback – Tachometer Feedback with Digital Hall Sensor Connection Diagram for Brushless Motors

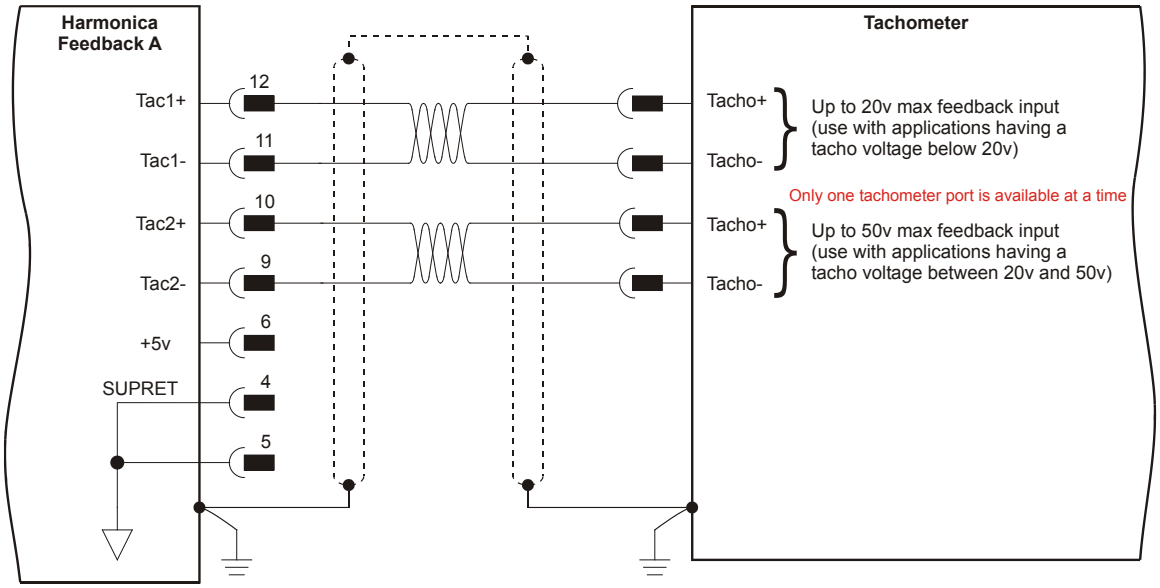


Figure 16: Main Feedback – Tachometer Feedback Connection Diagram for Brush Motors

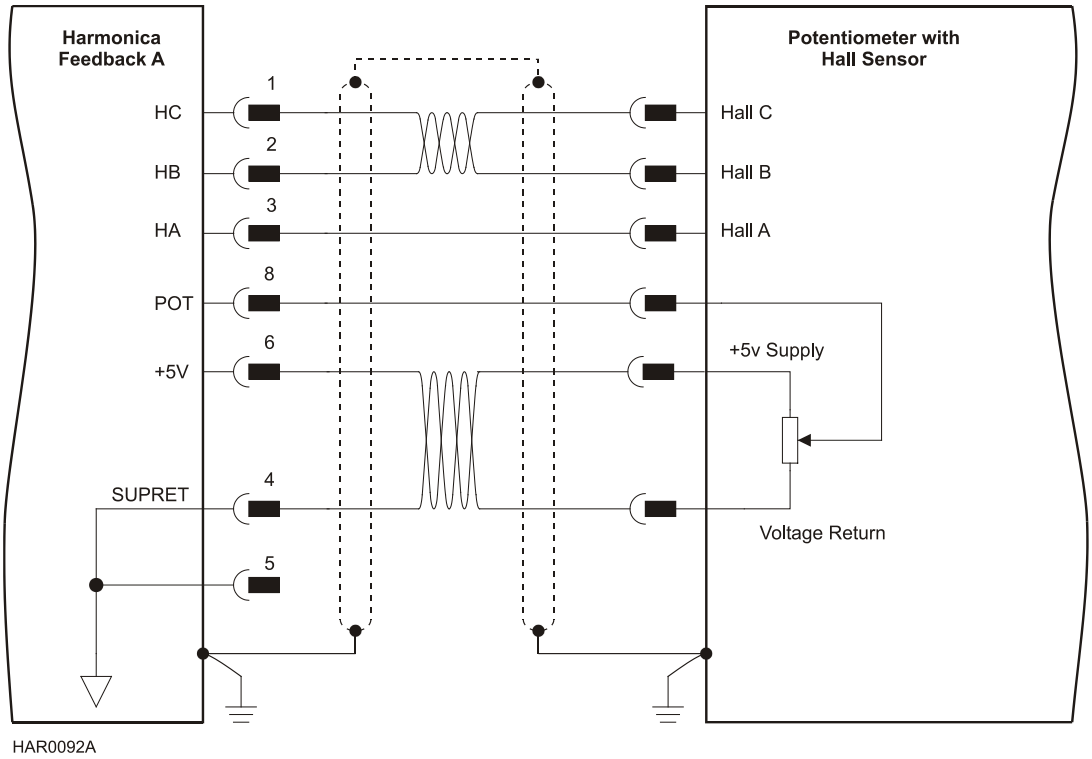


Figure 17: Main Feedback – Potentiometer Feedback with Digital Hall Sensor Connection Diagram for Brushless Motors

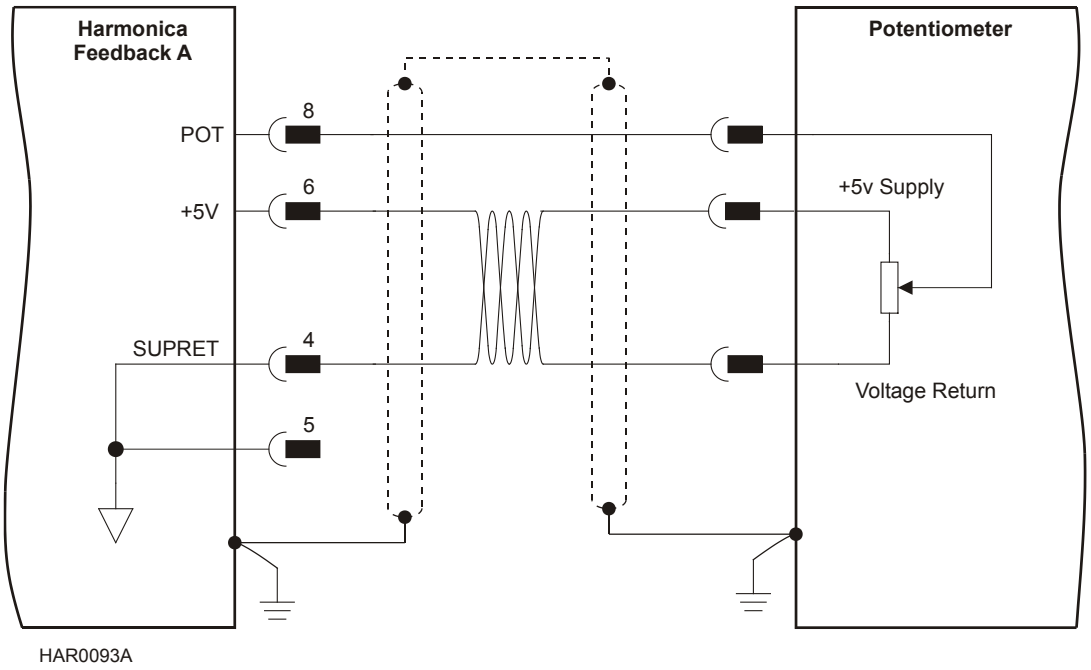


Figure 18: Main Feedback – Potentiometer Feedback Connection Diagram for Brush Motors and Voice Coils

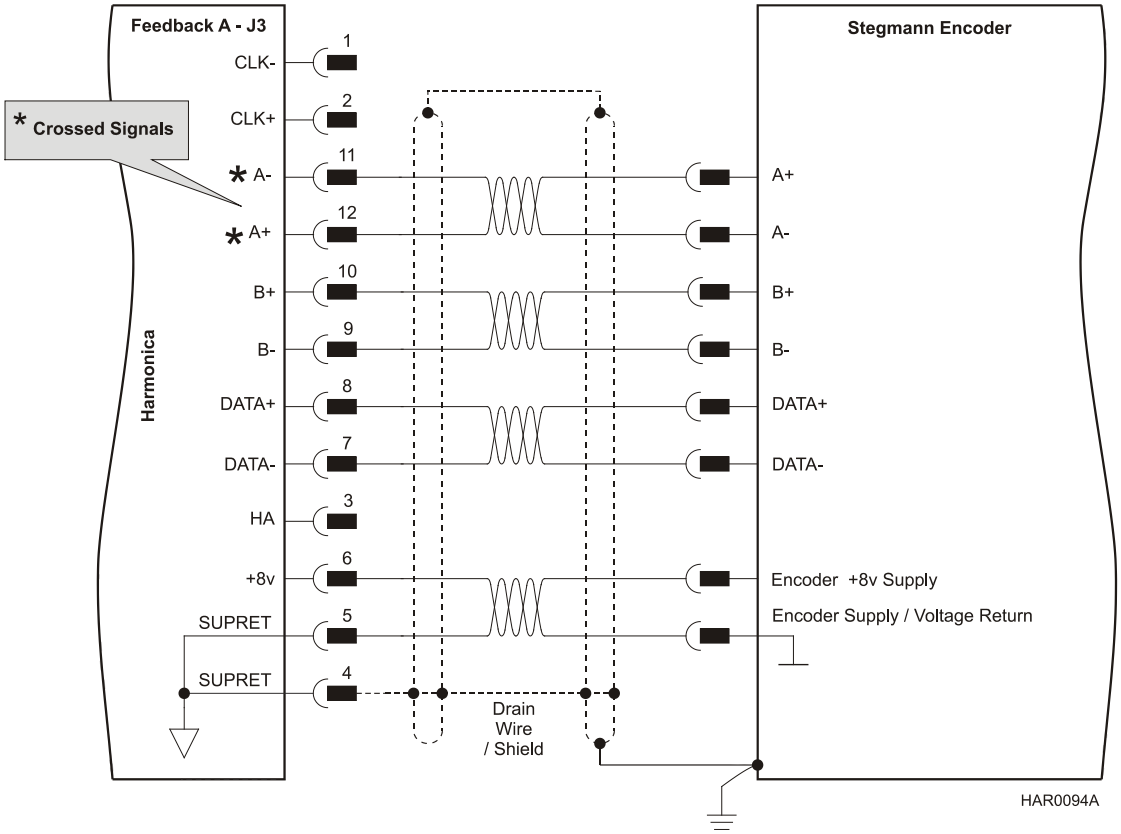


Figure 19: Main Feedback – Stegmann Feedback Connection Diagram

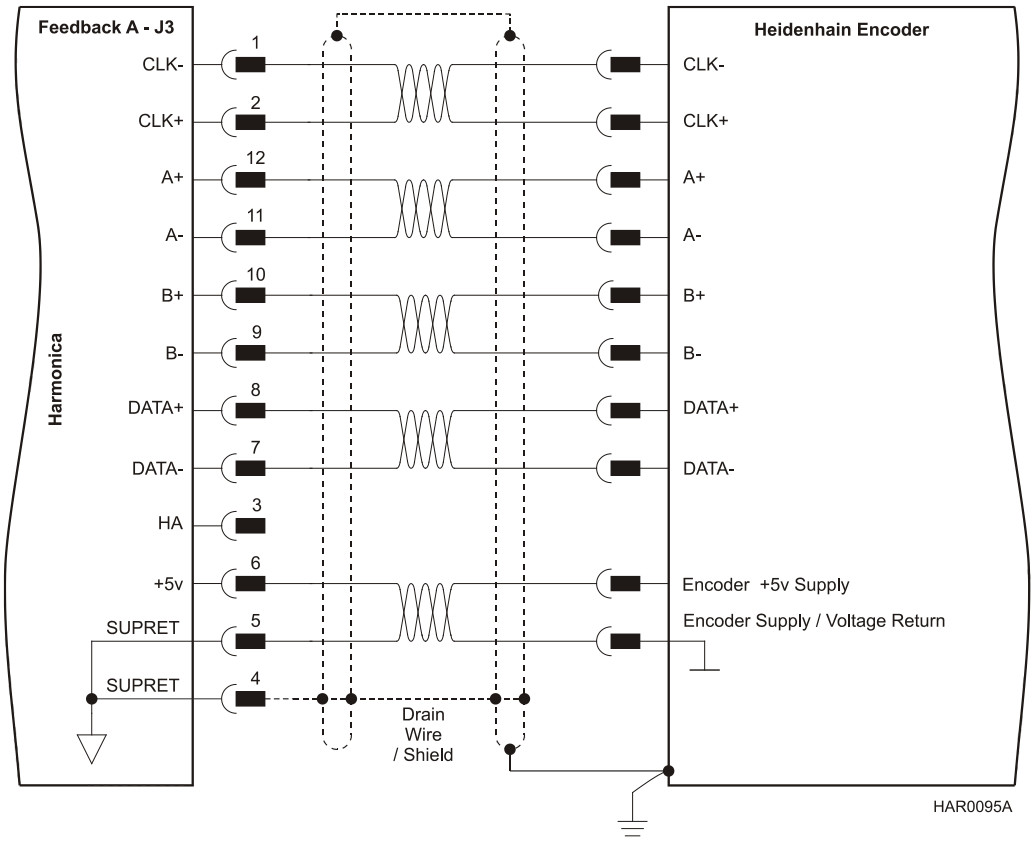


Figure 20: Main Feedback – Heidenhain Feedback Connection Diagram

3.5.5.2. Communication Cable (Port J1)

The communication cable uses an 8-pin RJ-45 plug that connects to the J1 port on the front of the Harmonica.

The communication interface may differ according to the user's hardware. The Harmonica can communicate using the following options:

a. RS-232, full duplex

b. CAN

RS-232 communication requires a standard, commercial 3-core null-modem cable connected from the Harmonica to a serial interface on the PC. The interface is selected and set up in the Composer software.

In order to benefit from **CAN** communication, the user must have an understanding of the basic programming and timing issues of a CAN network. The interface is electrically isolated by optocouplers.

For ease of setup and diagnostics of CAN communication, RS-232 and CAN can be used simultaneously.

3.5.5.2.a RS-232 Communication

Notes for connecting the RS-232 communication cable (J1 port):

- Use a 26 or 28 AWG twisted pair shielded cable. The shield should have aluminum foil and copper braid.
- Connect the shield to the ground of the host (PC). Usually, this connection is soldered internally inside the connector at the PC end. You can use the drain wire to facilitate connection.
- The male RJ plug must have a shield cover.
- Usually, the shield of the cable is soldered to the shield of the RJ plug. Ensure that it is connected in this manner.

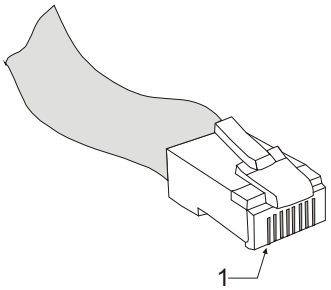
Pin	Signal	Function	Pin Location
1, 2	N/A	—	
3	Tx	RS-232 transmit	
4	N/A	—	
5	COMRET	Communication return	
6	Rx	RS-232 receive	
7, 8	N/A	—	

Table 6: RS-232 (J1) Cable Pin Assignments

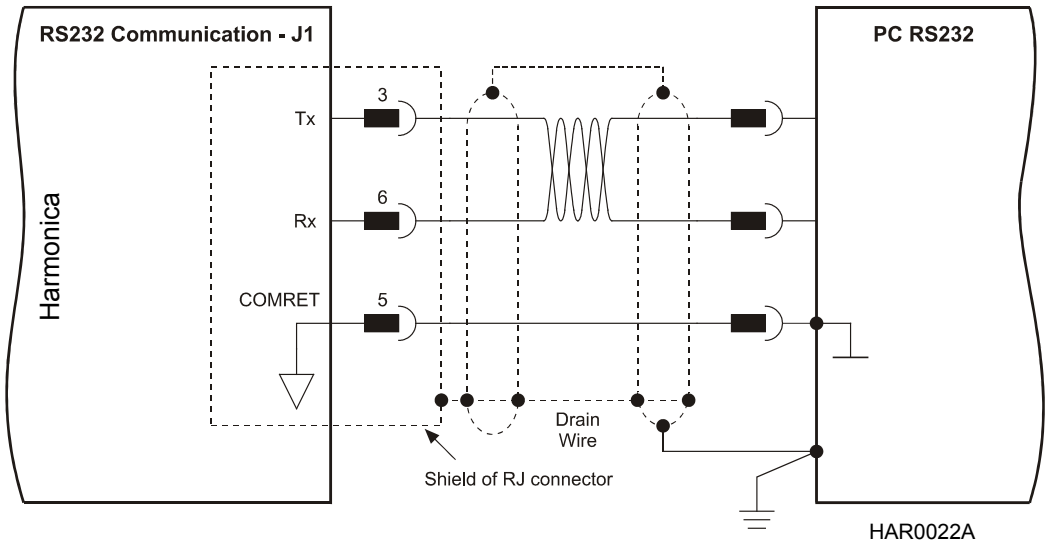


Figure 21: RS-232 Connection Diagram

3.5.5.2.b CAN Communication

Notes for connecting the CAN communication cable (J1 port):

- Use 26 or 28 AWG twisted pair shielded cables. For best results, the shield should have aluminum foil and copper braid.
- Connect the shield to the ground of the host (PC). Usually, this connection is soldered internally inside the connector at the PC end. You can use the drain wire to facilitate connection.
- The male RJ plug must have a shield cover.
- Usually, the shield of the cable is soldered to the shield of the RJ plug. Ensure that it is connected in this manner.
- Connect a termination 120-Ω resistor at each of the two ends of the network cable.

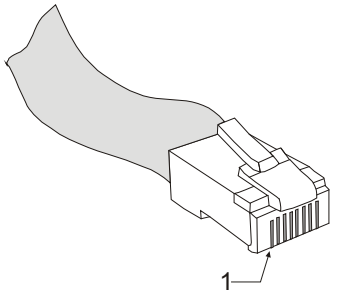
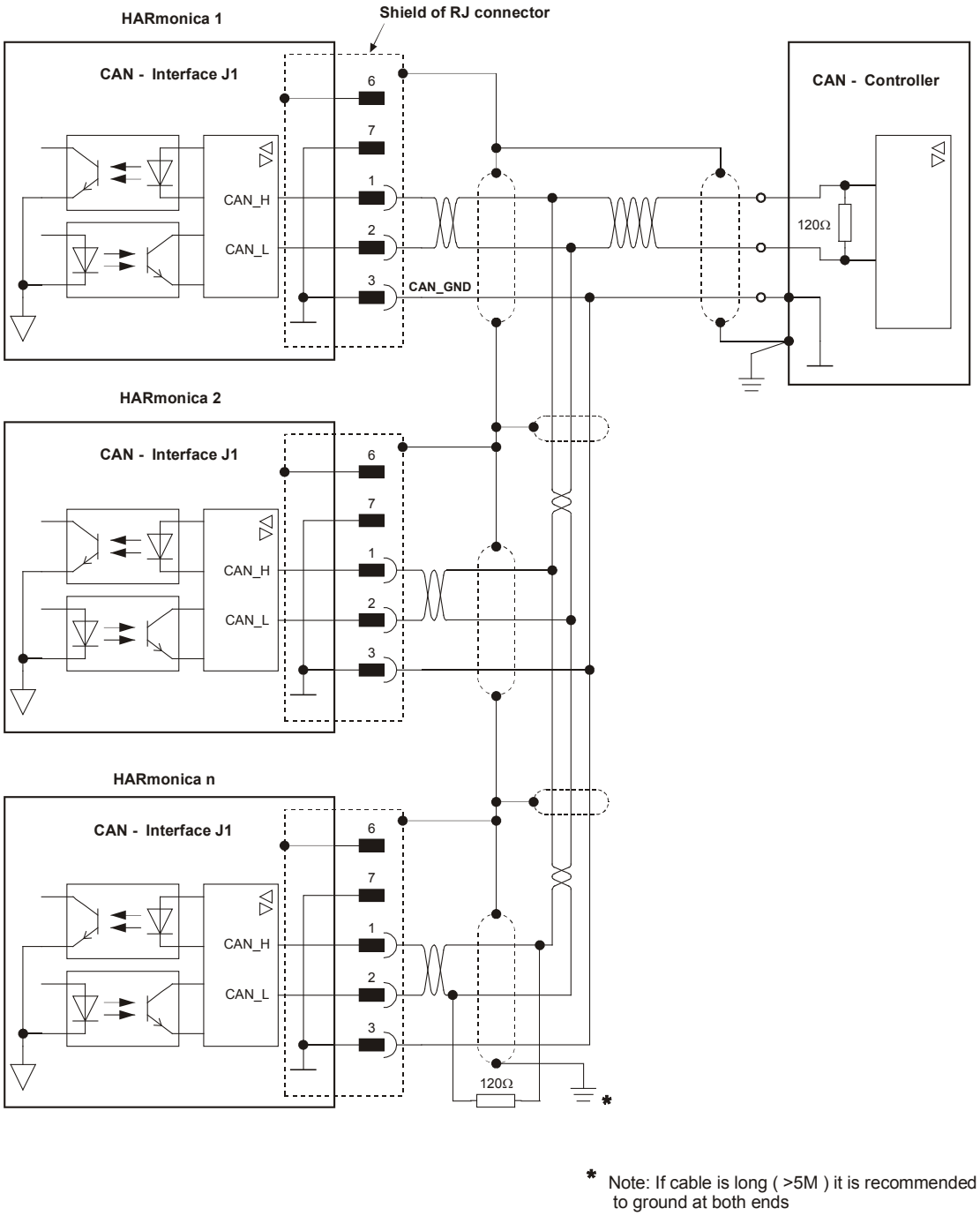
Pin	Signal	Function	Pin Positions
1	CAN_H	CAN_H busline (dominant high)	
2	CAN_L	CAN_L busline (dominant low)	
3	CAN_GND	CAN ground	
4, 5	N/A	—	
6	N/A	Shield, connected to the RJ plug cover	
7, 8	N/A	—	

Table 7: CAN (J1) Cable Pin Assignments



* Note: If cable is long (>5M) it is recommended to ground at both ends

Figure 22: CAN Connection Diagram

Caution:

When installing CAN communication, ensure that each servo drive is allocated a unique ID. Otherwise, the CAN network may hang.

3.5.5.3. I/O Cables

The following table lists the I/O cables that you should connect according to your specific requirements:

Cable	Description	No.	Port
Digital	Digital input	6	J5
Digital	Digital output	2	J6
Analog	Analog input	1	J7

3.5.5.3.a Digital Input (Port J5)

Notes for connecting the digital input cable:

- Use 24 , 26 or 28 AWG twisted pair shielded cable. For best results, the shield should have aluminum foil and copper braid.
- Connect the cable shield to the ground near the signal source (controller).

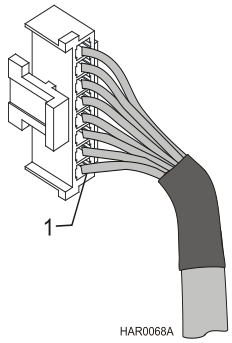
Pin (J5)	Signal	Function	Pin Positions
1	IN1	Programmable input 1 (general purpose, RLS, FLS, INH)	
2	IN2	Programmable input 2 (general purpose, RLS, FLS, INH)	
3	IN3	Programmable input 3 (general purpose, RLS, FLS, INH)	
4	IN4	Programmable input 4 (general purpose, RLS, FLS, INH)	
5	IN5	Programmable input 5 (event capture, Main Home, general purpose, RLS, FLS, INH)	
6	IN6	Programmable input 6 (event capture, Auxiliary Home, general purpose, RLS, FLS, INH)	
7	INRET	Programmable input return	
8	INRET	Programmable input return	

Table 8: Digital Input Cable Pin Assignment

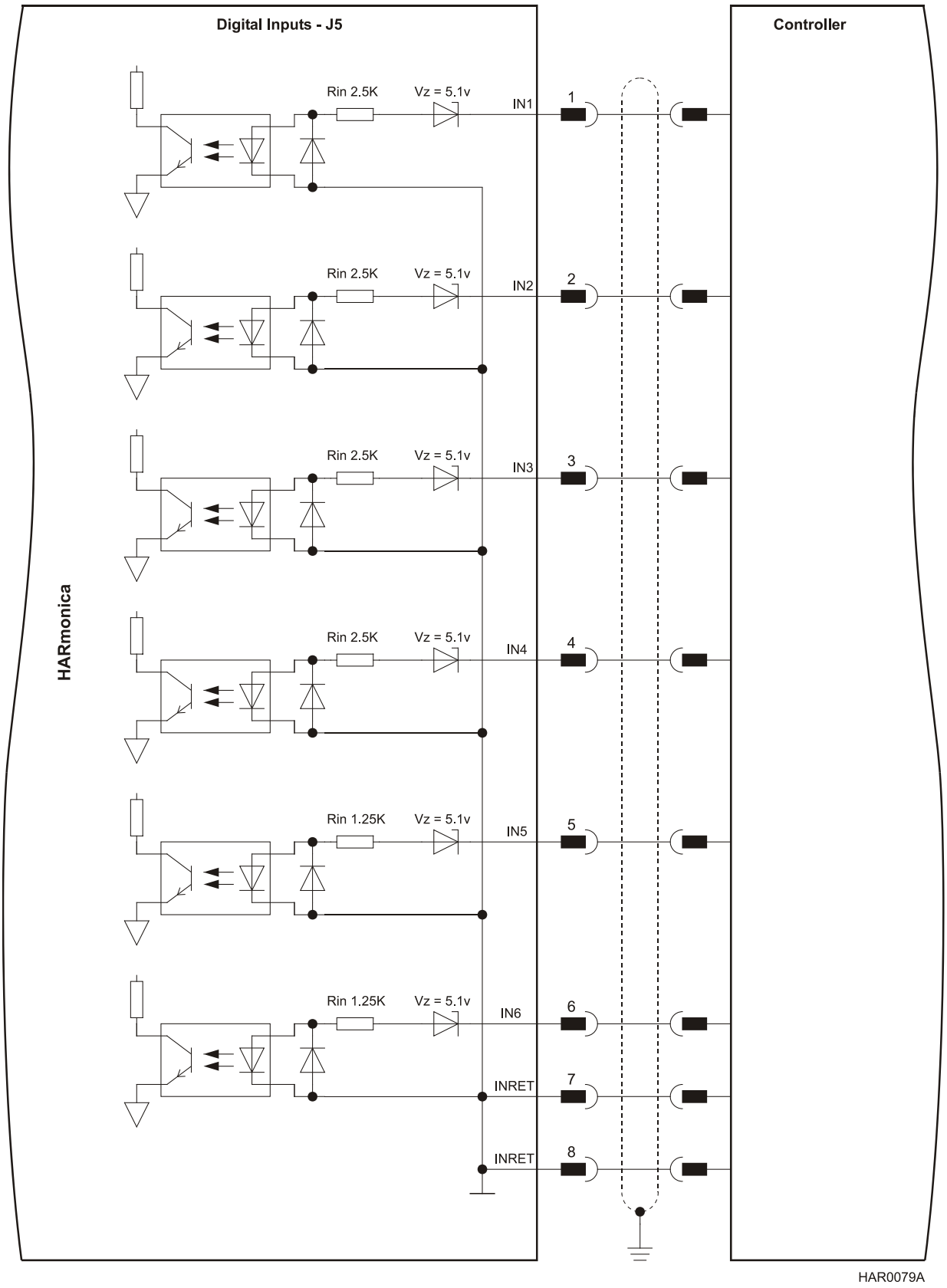


Figure 23: Digital Input Connection Diagram

3.5.5.3.b Digital Output (Port J6)

Notes for connecting the digital output cable:

- Use 24, 26 or 28 AWG twisted pair shielded cable. For best results, the shield should have aluminum foil and copper braid.
- Connect the cable shield to the ground near the controller.

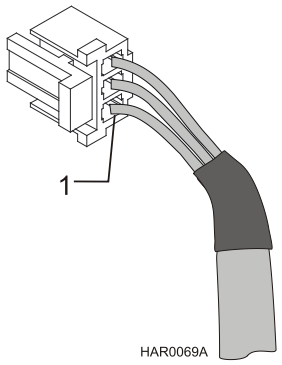
Pin	Signal	Function	Pin Positions
1	OUT1	Programmable output 1	
2	OUTRET1	Programmable output return 1	
3	OUT2	Programmable output 2	
4	OUTRET2	Programmable output return 2	

Table 9: Digital Output Cable Pin Assignment

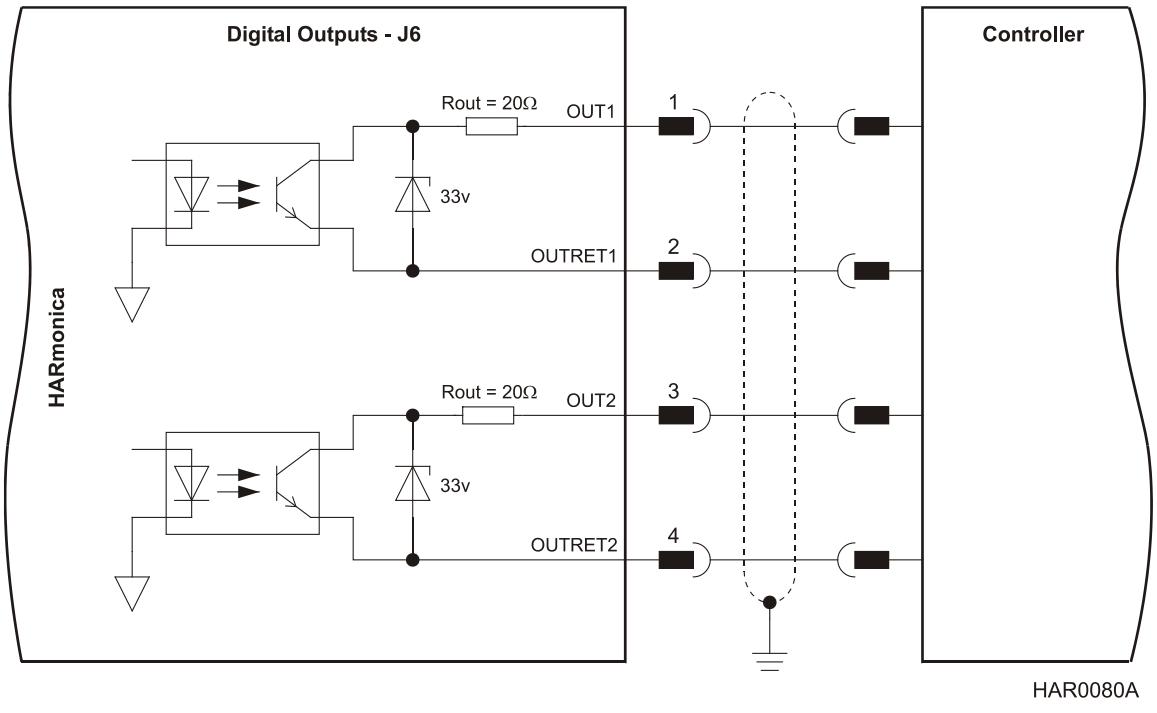


Figure 24: Digital Output Connection Diagram

3.5.5.3.c Analog Input (Port J7)

Notes for connecting the analog input cable:

- Use 24, 26 or 28 AWG twisted pair shielded cable. For best results, the shield should have aluminum foil and copper braid.
- Connect the cable shield to the ground near the signal source (controller).

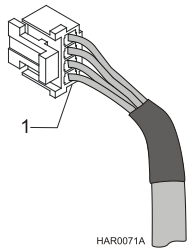
Pin (J7)	Signal	Function	Pin Positions
1	ANLIN1+	Analog input 1+	
2	ANLIN1-	Analog input 1-	
3	ANLRET	Analog ground	

Table 10: Analog Input Cable Pin Assignments

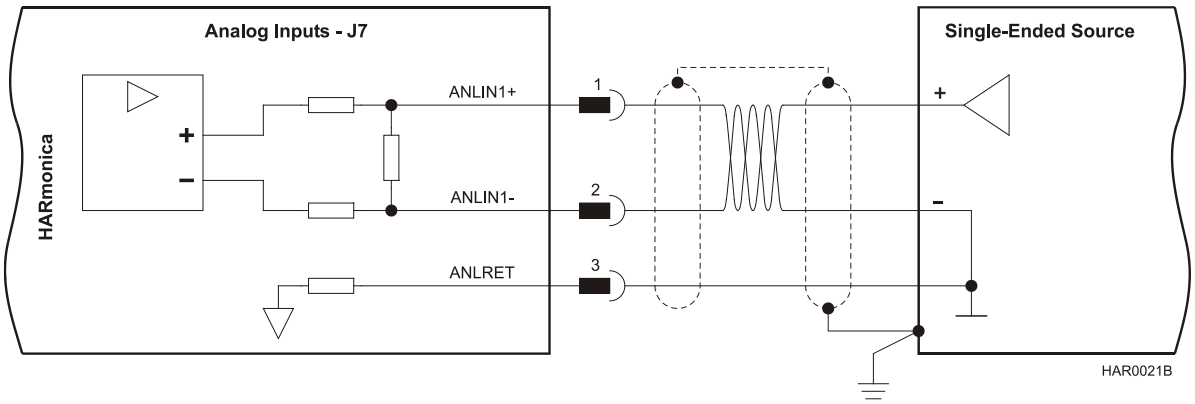


Figure 25: Analog Input with Single-Ended Source

3.5.5.4. Auxiliary Feedback (Port J2)

For auxiliary feedback, select one of the following options:

a. **Main encoder buffered outputs or emulated encoder outputs**, used to provide buffered main, or emulated, encoder signals to another controller or drive. This option can be used when:
   - The Harmonica is used as a current amplifier to provide position data to the position controller.
   - The Harmonica is used in velocity mode, to provide position data to the position controller.
   - The Harmonica is used as a master in follower or ECAM mode.

b. **Differential auxiliary inputs**, for the input of position data of the master encoder in follower or ECAM mode. This mode can also be used for differential pulse-and-direction position commands.

c. **Single-ended auxiliary input**, for the input of position data of the master encoder in follower or ECAM mode.

d. **Pulse-and-direction input**, for single-ended input of pulse-and-direction position commands.

e. **Differential pulse-and-direction input**, for differential input of pulse-and-direction commands.

When using one of the auxiliary feedback options, the relevant functionality of port J2 is software selected for that option. Refer to the Harmonica *Command Reference Manual* for detailed information about J2 setup.

Connect the auxiliary feedback cable into the J2 port on the front of the Harmonica, using an 8-pin, Molex plug.

Notes for connecting the auxiliary feedback cable (J2):

- Use 24, 26 or 28 AWG twisted pair shielded cables. For best results, the shield should have aluminum foil and copper braid.
- Ground the shield near the controller.

3.5.5.4.a Auxiliary Feedback: Main Encoder Buffered Output or Emulated Encoder Output Option (Port J2)

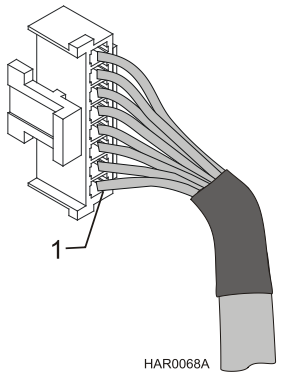
Pin	Signal	Function	Pin Positions
1	SUPRET	Supply return	
2	+5 V	NA	
3	INDEX-	Index complement output	
4	INDEXO	Index output	
5	CHBO-	Channel B complement output	
6	CHBO	Channel B output	
7	CHAO-	Channel A complement output	
8	CHAO	Channel A output	

Table 11: Main Encoder Buffered Output Pin Assignments on J2

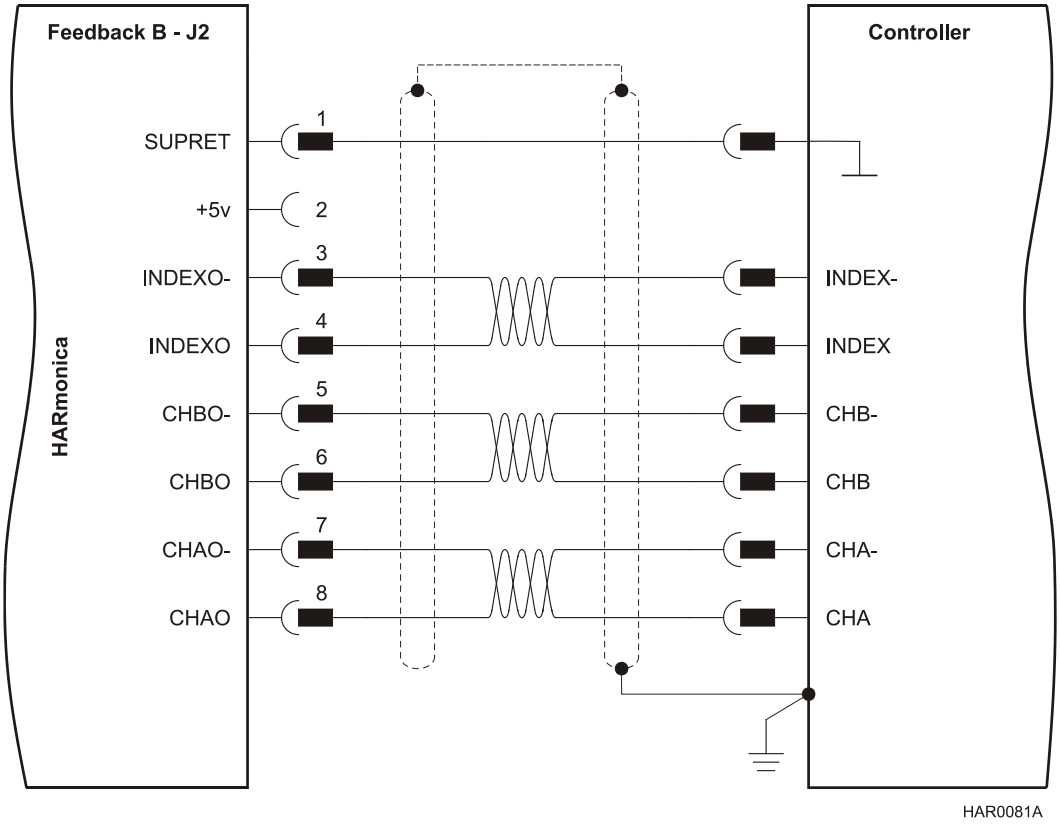


Figure 26: Main Encoder Buffered Output or Emulated Encoder Output on J2 - Connection Diagram

3.5.5.4.b Auxiliary Feedback: Differential Encoder Input Option (Port J2)

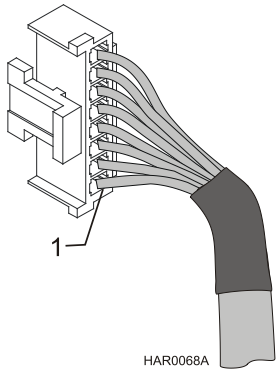
Pin	Signal	Function	Pin Positions
1	SUPRET	Supply return	
2	+5 V	Encoder + 5 V supply voltage, 5 V @ 200 mA	
3	INDEX-	Auxiliary index low input	
4	INDEX	Auxiliary index high input	
5	CHB-	Auxiliary channel B low input	
6	CHB	Auxiliary channel B high input	
7	CHA-	Auxiliary channel A low input	
8	CHA	Auxiliary channel A high input	

Table 12: Differential Auxiliary Encoder Pin Assignment on J2

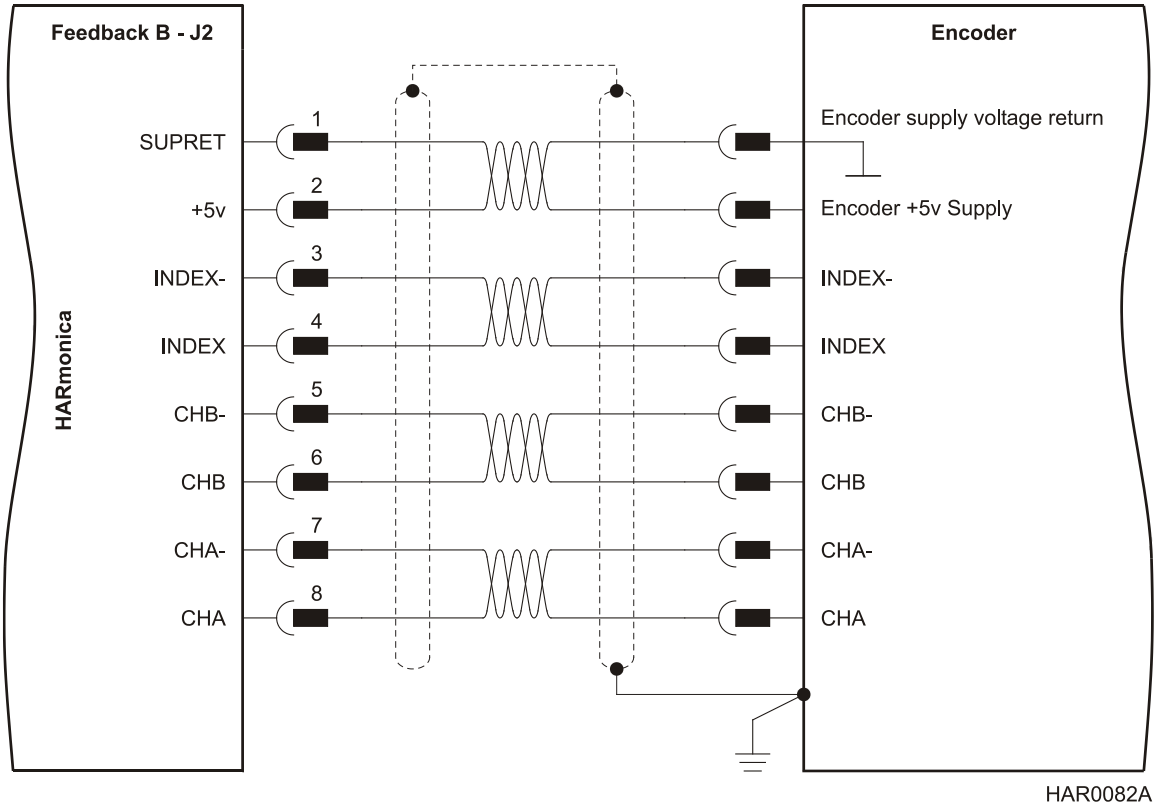


Figure 27: Differential Auxiliary Encoder on J2 - Connection Diagram

3.5.5.4.c Auxiliary Feedback: Single-Ended Encoder Input Option (Port J2)

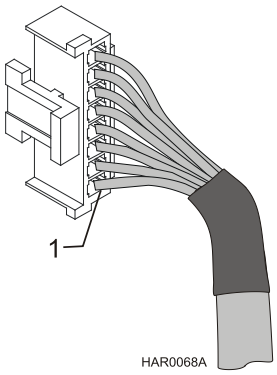
Pin	Signal	Function	Pin Positions
1	SUPRET	Supply return	
2	+5 V	Encoder/Hall +5 V supply voltage, 5 V @ 200 mA	
3	N/A	—	
4	INDEX	Index	
5	N/A	—	
6	DIR/CHB	Direction input (push/pull 5 V or open collector)	
7	N/A	—	
8	PULS/CHA	Pulse input (push/pull 5 V or open collector)	

Table 13: Single-Ended Auxiliary Encoder Pin Assignment on J2

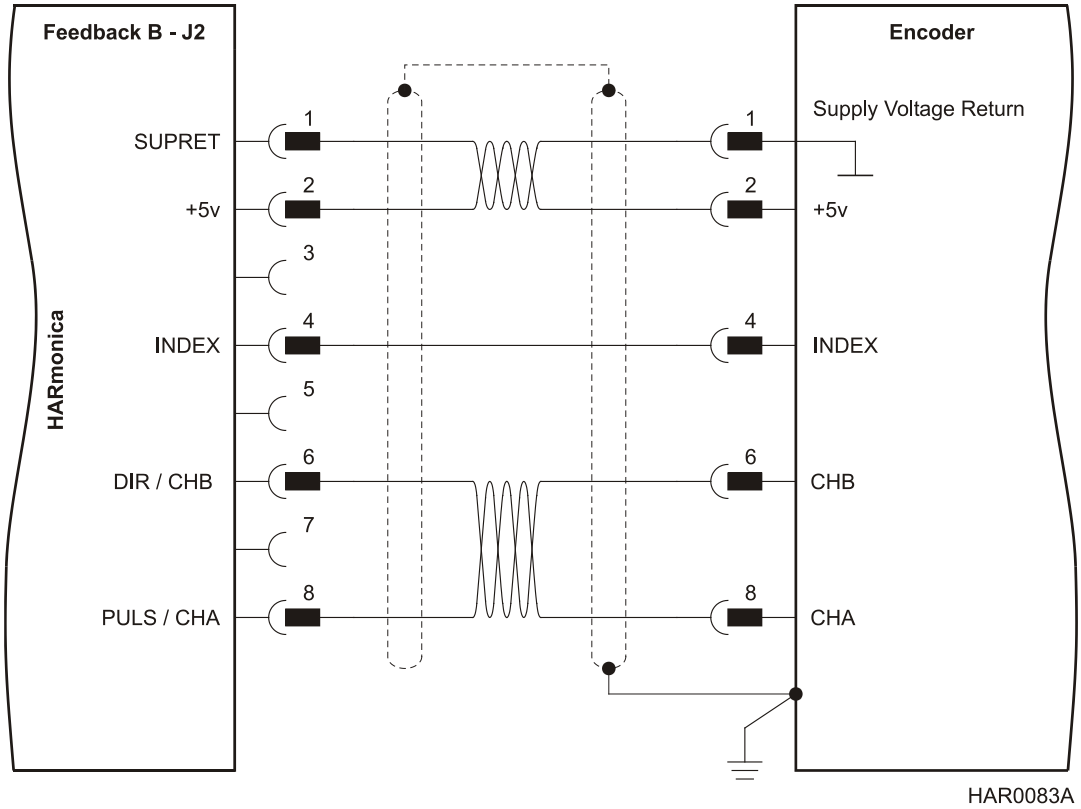


Figure 28: Single-Ended Auxiliary Encoder on J2 - Connection Diagram

3.5.5.4.d Auxiliary Feedback: Pulse-and-Direction Input Option (Port J2)

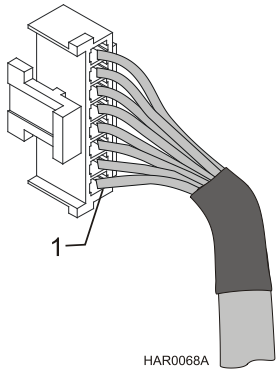
Pin	Signal	Function	Pin Positions
1	SUPRET	Supply return	
2	+5 V	N/A	
3,4,5	N/A	—	
6	DIR/CHB	Direction input (push/pull 5 V or open collector)	
7	N/A	—	
8	PULS/CHA	Pulse input (push/pull 5 V or open collector)	

Table 14: Pulse-and-Direction Auxiliary Encoder Pin Assignment on J2

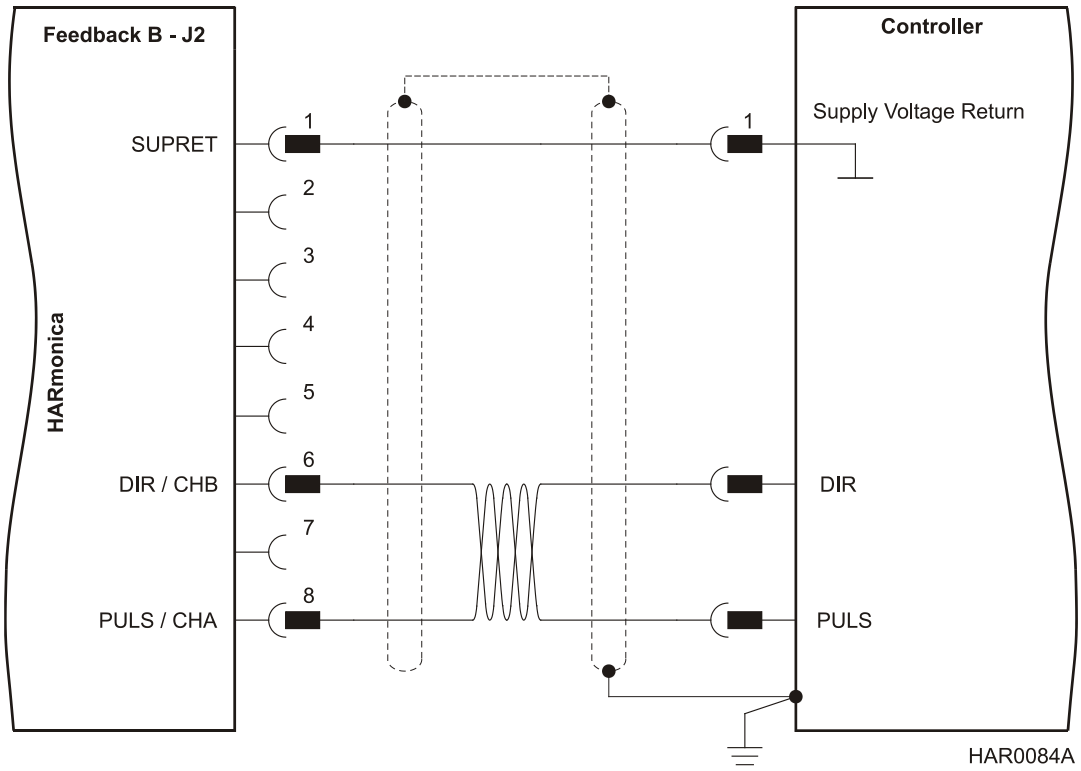


Figure 29: Pulse-and-Direction Auxiliary Encoder on J2 - Connection Diagram

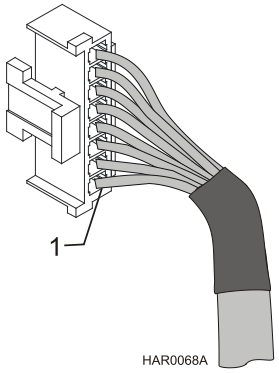
Pin	Signal	Function	Pin Positions
1	SUPRET	Supply return	
2	+5 V	N/A	
3, 4	N/A	—	
5	DIR-/CHB-	Direction low input	
6	DIR/CHB	Direction high input	
7	PULS-/CHA-	Pulse low input	
8	PULS/CHA	Pulse high input	

Table 15: Differential Pulse-and-Direction Auxiliary Encoder Pin Assignment on J2

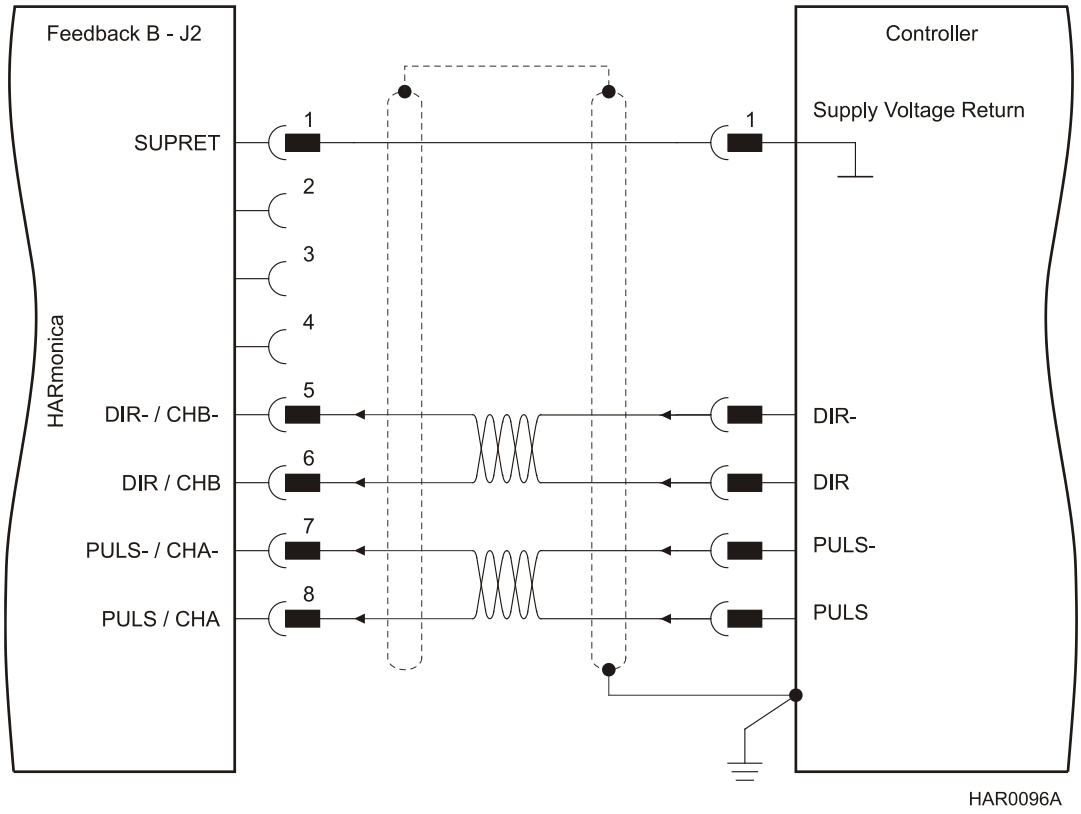


Figure 30: Differential Pulse-and-Direction Auxiliary Encoder on J2 - Connection Diagram

3.6. Powering Up

After the Harmonica has been mounted, check that the cables are intact. The Harmonica servo drive is then ready to be powered up.

Caution:
Before applying power, ensure that the DC supply is within the range specified for your specific type of Harmonica and that the proper plus-minus connections are in order.

To power up the system, first switch on the auxiliary power and then the main power supply. (Note that this order is recommended but not critical; if a problem occurs, the system is well protected.) The two-color LED turns green to indicate proper functioning.

3.7. Initializing the System

After the Harmonica has been connected and mounted, the system must be set up and initialized. This is accomplished using the *Composer*, Elmo's Windows-based software application. Install the application and then perform setup and initialization according to the directions in the *Composer Software Manual*.

Chapter 4: Technical Specifications

This chapter provides detailed technical information regarding the Harmonica. This includes its dimensions, power ratings, the environmental conditions under which it can be used, the standards to which it complies and other specifications.

4.1. Features

The Harmonica's features determine how it controls motion, as well as how it processes host commands, feedback and other input.

4.1.1. Motion Control Modes

- Current/Torque - up to 14 kHz sampling rate
- Velocity - up to 7 kHz sampling rate
- Position - up to 3.5 kHz sampling rate

4.1.2. Advanced Positioning Motion Control Modes

- PTP, PT, PVT, ECAM, Follower, Pulse and Direction, Dual Loop
- Fast event capturing inputs
- Fast output compare (OC)

4.1.3. Advanced Filters and Gain Scheduling

- “On-the-Fly” gain scheduling of current and velocity
- Velocity and position with “1-2-4” PIP controllers
- Automatic commutation alignment
- Automatic motor phase sequencing

4.1.4. Fully Programmable

- Third generation programming structure with motion commands
- Event capturing interrupts
- Event triggered programming

4.1.5. Feedback Options

- Incremental Encoder – up to 20 Mega-Counts (5 Mega-Pulse)
- Digital Halls – up to 2 kHz
- Incremental Encoder with Digital Halls for commutation – up to 20 Mega-Counts
- Absolute Encoder
- Interpolated Analog (Sine/Cosine) Encoder – up to 250 kHz
  - Internal Interpolation - up to X4096
  - Automatic Correction of amplitude mismatch, phases mismatch, signals offset
  - Encoder outputs, buffered, differential.
- Resolver
  - Programmable 10 to 15 bit resolution
  - Up to 512 revolutions per second (RPS)
  - Encoder outputs, buffered, differential
- Elmo drives provide supply voltage for all the feedback options

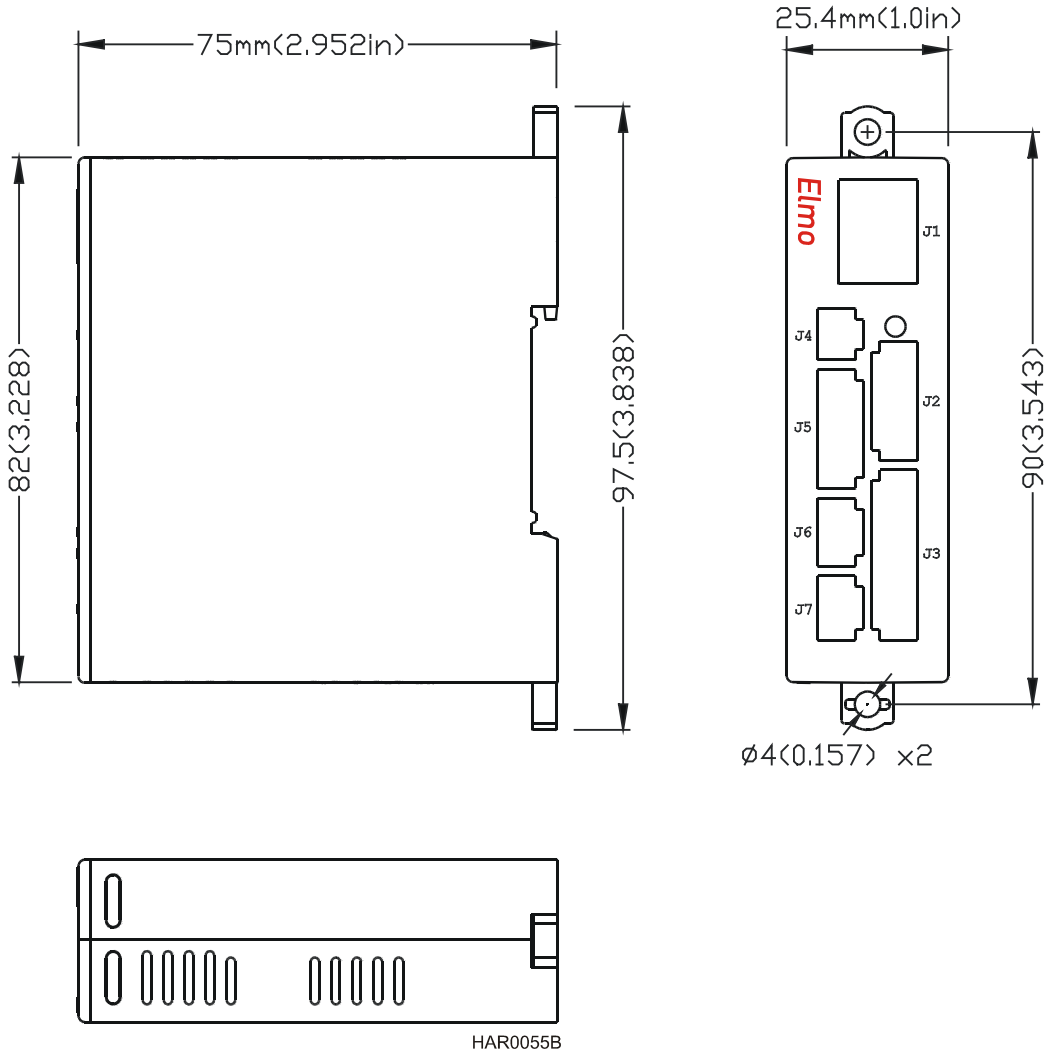
4.1.6. Input/Output

- Analog Inputs with up to 14-bit resolution
- Programmable digital inputs, optically isolated
  - Inhibit/Enable motion
  - Software and analog reference stop
  - Motion limit switches
  - Begin on input
  - Abort motion
  - General-purpose
  - Homing
- Fast event capture inputs, optically isolated
- Programmable digital outputs
  - Brake Control
  - Amplifier fault indication
  - General-purpose
  - Servo enable indication
- Buffered and differential outputs of the main encoder with up to 5 MHz pulses
- Emulated output of the resolver or interpolated analog encoder
- Fast output compare (OC), optically isolated

4.1.7. Built-In Protection

- Software error handling
- Abort (hard stops and soft stops)
- Status reporting
- Overheating temperature protection feature with a threshold and tolerance, of 87 °C ± 3 °C
- Protection against
  - Shorts between motor power outputs
  - Shorts between motor power output and power input/return
  - Failure of internal power supplies
  - Over/Under voltage
  - Loss of feedback
  - Following error
  - Current limits

4.2. Harmonica Dimensions



4.3. Power Ratings

Feature	Units	5/60	8/60	12/60	2/100	4/100	8/100	12/100	1/200	2/200	4/200	6/200
Minimum supply voltage	VDC	10			20				40			
Nominal supply voltage	VDC	50			85				170			
Maximum supply voltage	VDC	59			95				195			
Maximum continuous power output	W	250	400	650	200	320	640	1100	200	320	640	1100
Efficiency at rated power (at nominal conditions)	%	> 97										
Maximum output voltage		>97% of DC bus voltage at f=22 kHz										
Auxiliary supply voltage	VDC	24 ± 20%										
Auxiliary power supply	VA	8										
Amplitude sinusoidal/DC continuous current	A	5	8	13.3	2.5	4	8	13.3	1.25	2	4	6.6
Sinusoidal continuous RMS current limit (Ic)	A	3.5	5.7	9.4	1.8	2.8	5.7	9.4	0.9	1.4	2.8	4.7
Peak current limit	A	2 x Ic										
RMS output power without heatsink	%	100	50	20	100	50	20	20	100	50	20	20
Weight	g (oz)	150 g (5.3 ounces)										
Dimensions	mm (in)	82 x 25.4 x 75 (3.2" x1.0" x 3.0")										
Digital in/Digital out/Analog in		6/2/1										
Mounting method		Wall mount (“Bookshelf”) or DIN rail										

4.4. Environmental Conditions

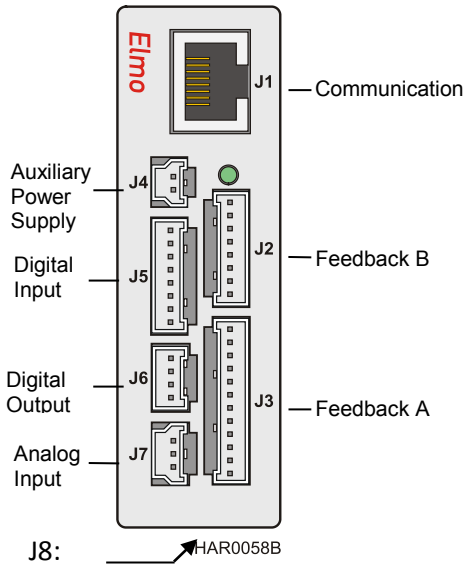
Feature	Details
Operating ambient temperature according to IEC60068-2-2	0 °C to 40 °C (32 °F to 104 °F)
Storage temperature	-20 °C to +85 °C (-4 °F to +185 °F)
Maximum non-condensing humidity according to IEC60068-2-78	95%
Maximum Operating Altitude	2,000 m (6562 feet)
Mechanical Shock according to IEC60068-2-27	15g / 11ms Half Sine
Vibration according to IEC60068-2-6	5 Hz ≤ f ≤ 10 Hz: ±10mm 10 Hz ≤ f ≤ 57 Hz: 4G 57 Hz ≤ f ≤ 500 Hz:5G

4.5. Harmonica Connectors

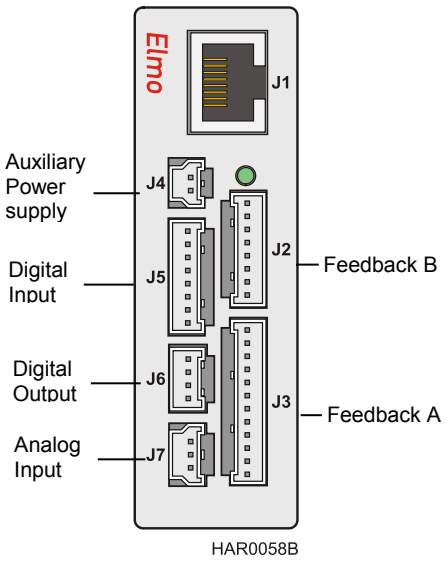
The following connectors are used for wiring the Harmonica.

4.5.1. Connector Types

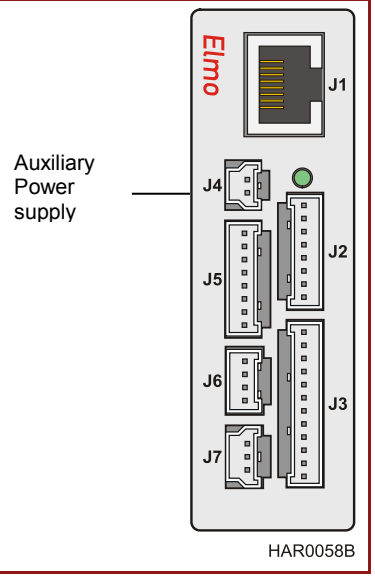
The table below shows the connector panel of the Harmonica. The *Harmonica Cable Starting Kit* (Cat. No. HAR-CABLEKIT) describes each connector cable in great detail.

Pins	Type	Connector Maker & No. / Mating Plug (on Cable)	Port	Connector Locations
8	RJ-45	RJ-45 jack / mates with RJ-45 plug	J1	
8	2 mm Pitch	Molex 35363-0800 / mates with 35507-0800	J2	
12	2 mm Pitch	Molex 35363-1200 mates with 35507-1200	J3	
2	2 mm Pitch	Molex 35363-0200 mates with 35507-0200	J4	
8	2 mm Pitch	Molex 35363-0800 mates with 35507-0800	J5	
4	2 mm Pitch	Molex 35363-0400 mates with 35507-0400	J6	
3	2 mm Pitch	Molex 35363-0300 mates with 35507-0300	J7	
7	5.08 mm Pitch Terminal Block	Phoenix MSTBA 2.5/7-G-5.08 with MSTB 2.5/7-ST-5.08	J8	

4.5.2. Control and Feedback Connector Specifications

Feature	Details	Connector Location
Product name	Sherlock	
Manufacturer	Molex	
Wire size	24, 26, 28, 30 AWG	
Maximum current	2 A	
Temperature range	-40 °C to 105 °C (-40 °F to 221 °F)	
Plating contact	Tin/Lead (Sn/Pb)	
Maximum voltage	125 V	
Contact resistance	< 20 mΩ	
Withstanding voltage	500 VAC	
Insulation resistance	> 1000 MΩ	
Terminal contact	Phosphor bronze	
UL files	E29179, UL 94 V-0	
Cable connector	Molex 35507-XX00, where XX is the number of leads	
Hand crimper	Molex 63811-1200	
Crimp terminal	Molex 50212	

4.6. Auxiliary Power Supply (J4)

Feature	Details	Connector Location
Auxiliary power supply	***DC source only***	
Auxiliary supply input voltage	24 V ±20%	
Auxiliary supply input power	8 VA (maximum)	

4.7. Control Specifications

4.7.1. Current Loop

Feature	Details
Controller type	Vector, digital
Compensation for bus voltage variations	On-the-fly automatic gain scheduling
Motor types	• AC brushless (sinusoidal) • DC brushless (trapezoidal) • DC brush • Linear Motors • Moving coils
Current control	• Fully digital • Sinusoidal with vector control • Programmable PI control filter based on a pair of PI controls of AC current signals and constant power at high speed
Current loop bandwidth	<2.5 kHz
Current sampling time	Programmable 70 to 100 µsec
Current sampling rate	Up to 16 kHz; default 11 kHz

4.7.2. Velocity Loop

Feature	Details
Controller type	PI
Velocity control	• Fully digital • Programmable PI and FFW control filters • On-the-fly gain scheduling • Automatic, manual and advanced manual tuning
Velocity and position feedback options	• Incremental Encoder • Digital Halls • Interpolated Analog (Sine/Cosine) Encoder (optional) • Resolver (optional)
Velocity command options	• Analog • Internally calculated by either jogging or step **Note:** All software-calculated profiles support on-the-fly changes.
Velocity loop bandwidth	<350 Hz
Velocity loop sampling time	140 to 200 µsec (x2 current loop sample time)
Velocity loop sampling rate	Up to 8 kHz; default 5.5 kHz

4.7.3. Position Loop

Feature	Details
Controller type	“1-2-4” PIP
Position command options	• Software • Pulse and Direction • Analog Potentiometer
Position loop bandwidth	<80 Hz
Position loop sampling time	280 to 400 µsec (x 4 current loop sample time)
Position loop sampling rate	Up to 4 kHz; default 2.75 kHz

4.8. Feedback

The Harmonica can receive and process feedback input from diverse types of devices.

4.8.1. Feedback Supply Voltage

Feature	Details
J3 (main encoder) supply voltage	5 V ±5% @ 200 mA maximum
J2 (auxiliary encoder) supply voltage	5 V ±5% @ 200 mA maximum

4.8.2. Incremental Encoder

Feature	Details
Encoder format	• A, B and Index • Differential • Quadrature
Interface:	RS-422
Input resistance:	Differential: 120 Ω
Maximum incremental encoder frequency	Maximum absolute: 5 MHz pulses
Minimum quadrature input period (P_{IN})	112 nsec
Minimum quadrature input high/low period (P_{HL})	56 nsec
Minimum quadrature phase period (P_{PH})	28 nsec
Maximum encoder input voltage range	Common mode: ±7 V Differential mode: ±7 V

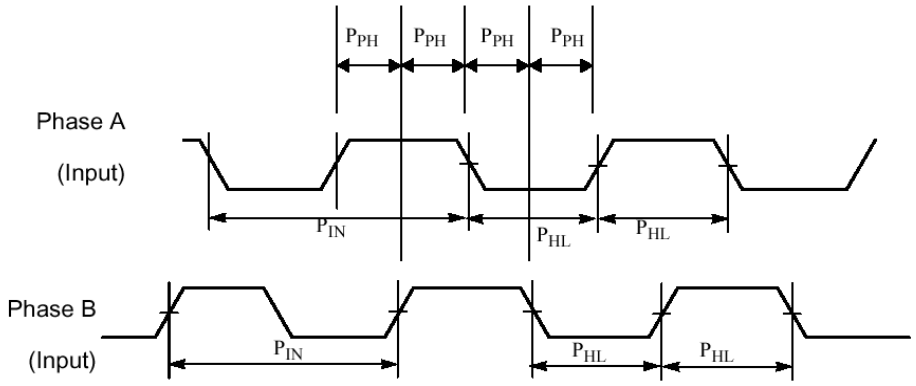


Figure 31: Encoder Phase Diagram

4.8.3. Digital Halls

Feature	Details
Halls inputs	• H_A, H_B, H_C. • Single ended inputs • Built in hysteresis for noise immunity.
Input voltage	Nominal operating range: 0 V < V_{In_Hall} < 5 V Maximum absolute: -1 V < V_{In_Hall} < 15 V High level input voltage: V_{InHigh} > 2.5 V Low level input voltage: V_{InLow} < 1 V
Input current	Sink current (when input pulled to the common): 3 mA Source current: 1.5 mA (designed to support open collector Halls as well)
Maximum frequency	f_{MAX} : 2 kHz

4.8.4. Interpolated Analog (Sine/Cosine) Encoder

Feature	Details
Analog encoder format	Sine and Cosine signals
Analog input signal level	Offset voltage: 2.2 V to 2.8 V Differential, 1 V peak to peak
Input resistance	Differential 120 Ω
Maximum analog signal frequency	f_{MAX} : 250 kHz
Interpolation multipliers	Programmable: x4 to x4096
Maximum “counts” frequency	80 mega-counts/sec “internally”
Automatic errors correction	Signals amplitude mismatch Signals phase shift Signals offset
Encoder outputs	See Section 4.8.6

4.8.5. Resolver

Feature	Details
Resolver format	• Sine/Cosine • Differential
Input resistance	Differential 2.49 kΩ
Resolution	Programmable: 10 to 15 bits
Maximum electrical frequency (RPS)	512 revolutions/sec
Resolver transfer ratio	Meets ratio of 0.5
Reference frequency	1/Ts (Ts = sample time in kHz)
Reference voltage	Supplied by the Harmonica
Reference current	Up to ±50 mA
Encoder outputs	See Section 4.8.6

4.8.6. Tachometer*

Feature	Details
Tachometer format	Differential
Maximum operating differential voltage for TAC1+, TAC1-	±20 V
Maximum absolute differential input voltage for TAC1+, TAC1-	±25 V
Maximum operating differential voltage for TAC2+, TAC2-	±50 V
Maximum absolute differential input voltage for TAC2+, TAC2-	±60 V
Input resistance for TAC1+, TAC1-	46 kΩ
Input resistance for TAC2+, TAC2-	100 kΩ
Resolution	14 bit

***** Only one Tachometer port can be used at a time (either TAC1+/TAC1- or TAC2+/TAC2-).
TAC1+/TAC1- is used in applications with having a Tachometer of less than 20 V.
TAC2+/TAC2- is used in applications with having a Tachometer of between 20 V and 50 V.

4.8.7. Potentiometer

Feature	Details
Potentiometer Format	Single-ended
Operating Voltage Range	0 to 5 V supplied by the Harmonica
Potentiometer Resistance	100 Ω to 1 kΩ … above this range, linearity is affected detrimentally
Input Resistance	100 kΩ
Resolution	14 Bit

4.8.8. Encoder Outputs

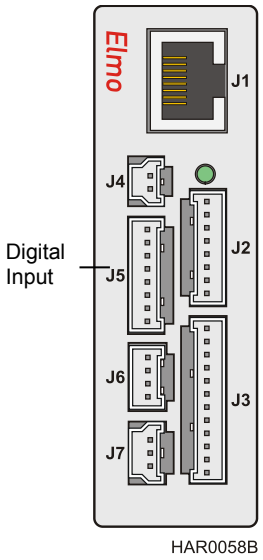
Feature	Details
Encoder output format:	• A, B, Index • Differential outputs • Quadrature
Interface	RS-422
Output current capability:	Driving differential loads of 200 Ω
Available at options	• Buffered outputs of main-input incremental encoder • Emulated encoder outputs of analog encoder • Emulated encoder outputs of the resolver
Maximum frequency	f_{MAX} : 5 MHz pulses/output
Index (marker):	Length of pulse is one quadrature (one quarter of an encoder cycle) and synchronized to A&B

4.9. I/Os

The Harmonica has:

- 6 Digital Inputs
- 2 Digital Outputs
- 1 Analog Input

4.9.1. Digital Input Interfaces

Feature	Details	Connector Location
Type of input	• Optically isolated • Single ended	 HAR0058B
Input current	$Iin = \frac{Vin - 6.5V}{2500\Omega}$ * Iin = 2.2 mA @ Vin = 12 V	
Input current for high speed inputs	$Iin = \frac{Vin - 6.5V}{1250\Omega}$ * Iin = 4.4 mA @ Vin = 12 V	
High-level input voltage	12 V < Vin < 30 V, 24 V typical	
Low-level input voltage	0 V < Vin < 6.5 V	
Minimum pulse width	> 4 x TS, where TS is sampling time	
I/O inputs	PLC level only	
Execution time (all inputs): the time from application of voltage on input until execution is complete	If input is set to one of the built-in functions — Home, Inhibit, Hard Stop, Soft Stop, Hard and Soft Stop, Forward Limit, Reverse Limit or Begin — execution is immediate upon detection: 0 < T < 4 x TS If input is set to General input, execution depends on program. Typical execution time: ≅ 0.5 msec.	
High-speed inputs - minimum pulse width, in high-speed mode	T < 5 µsec **Notes:** • Home mode is high-speed mode and can be used for fast capture and precise homing. • High speed input has a digital filter set to same value as digital filter (EF) of main encoder. • Highest speed is achieved when turning on optocouplers.	

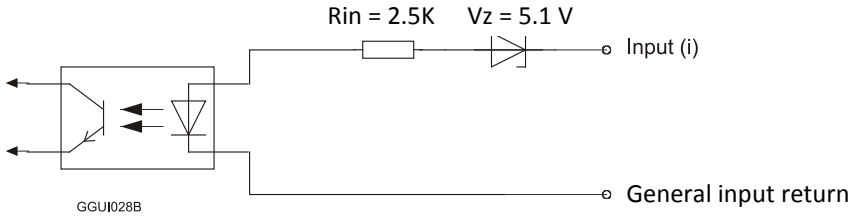
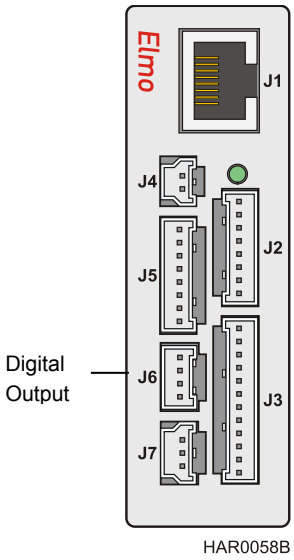


Figure 32: Digital Input Schematic

4.9.2. Digital Output Interface

Feature	Details	Connector Location
Type of output	• Optically isolated • Open collector and open emitter	
Maximum supply output (Vcc)	30 V	
Maximum output current Io (max) (Vout = Low)	Iout (max) ≤ 10 mA	
VOL @ maximum output voltage (low level)	Vout (on) ≤ 0.3 V + 0.02 * Iout (10 mA)	
RL	External resistor RL must be selected to limit output current to no more than 10 mA. $R_L = \frac{Vcc - VOL}{Io(\max)}$	
Executable time	If output is set to one of the built-in functions — Home flag, Brake or AOK — execution is immediate upon detection: 0 < T < 4 x TS If output is set to General output and is executed from a program, the typical time is approximately 0.5 msec.	

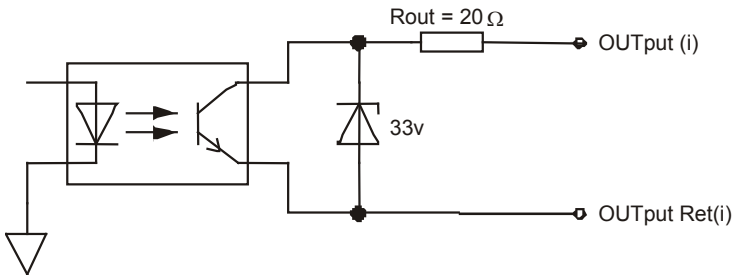
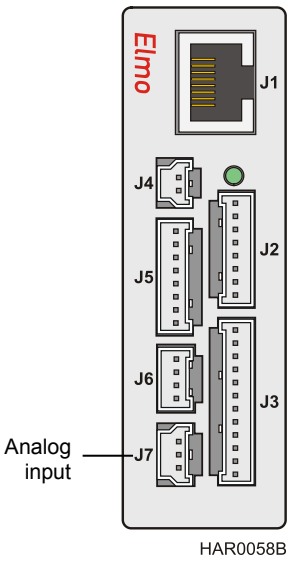
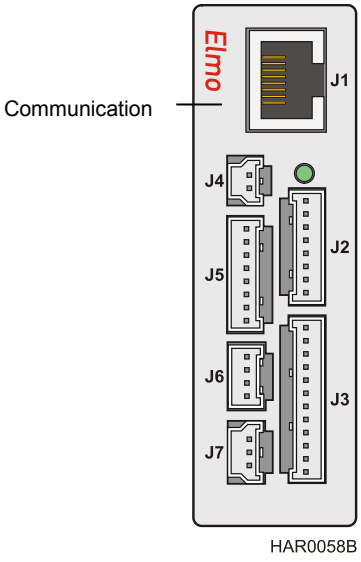


Figure 33: Digital Output Schematic

4.9.3. Analog Input (J7)

Feature	Details	Connector Location
Maximum operating differential mode voltage	±10 V	
Maximum absolute differential input voltage	±16 V	
Differential input resistance	3 kΩ	

4.10. Communications

Specification	Details	Connector Location
RS-232	**Signals:** • RxD , TxD , Gnd • Full duplex, serial communication for setup and control. • Baud Rate of 9,600 to 57,600 bits/sec	
CAN	**CAN bus Signals:** • CAN_H, CAN_L, CAN_GND • Maximum Baud Rate of 1 Mbits/sec. **Version:** • DS 301 V4.01 **Device Profile** (drive and motion control)**:** • DS 402	

4.11. Pulse-Width Modulation (PWM)

Feature	Details
PWM resolution	12-bit
PWM switching frequency on the load	2/ Ts (factory default 22 kHz on the motor)

4.12. Heatsink Specifications

The following table indicates the RMS output power when operating the Harmonica at nominal DC bus voltage:

Harmonica	5/60	8/60	12/60	2/100	4/100	8/100	12/100	1/200	2/200	4/200	6/200
RMS output power without heatsink (%)	100	50	20	100	50	20	20	100	50	20	20

*50 V models are no longer available for new designs.

If the input voltage is lower, the RMS output current without a heatsink is higher.

Three types of heatsinks are recommended for ensuring maximum continuous output power of the drive:

- Flat plate heatsink
- Fin heatsink
- L-Shaped heatsink

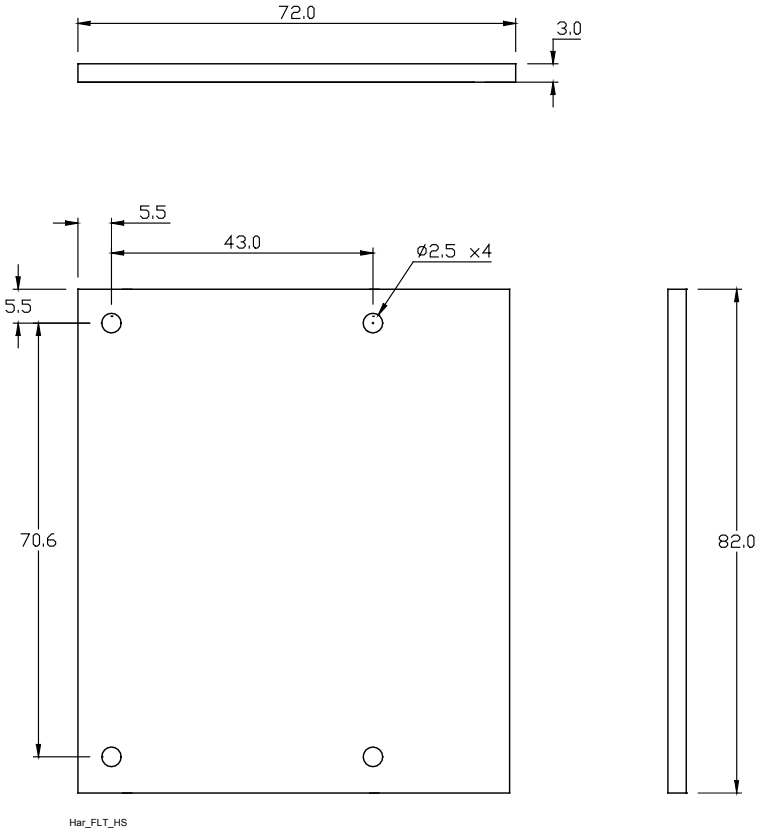


Figure 34: Flat-Plate Heatsink Dimensions

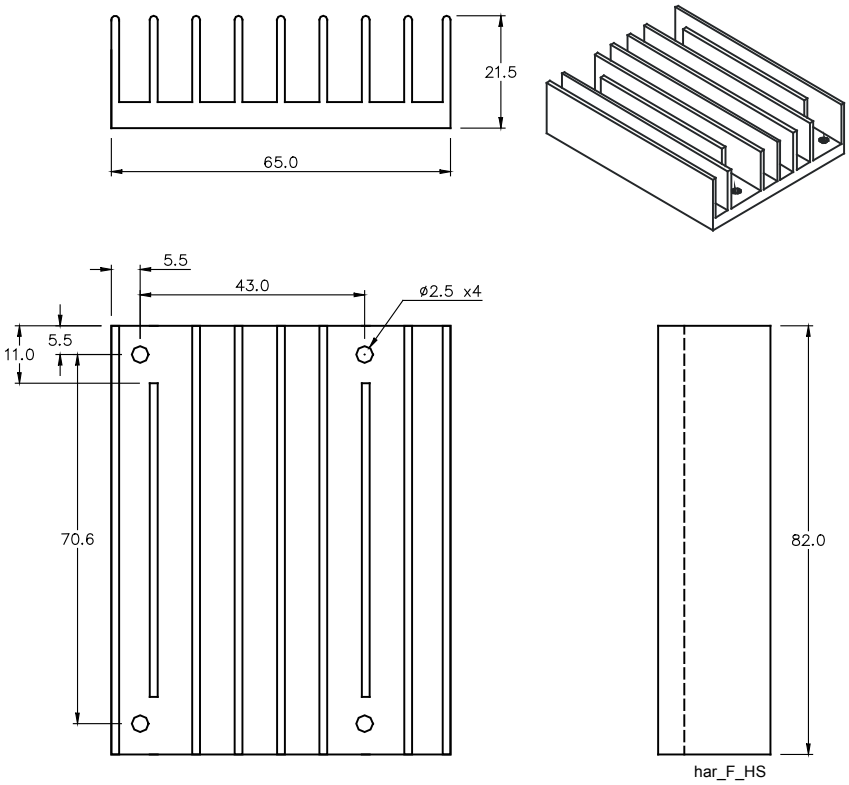


Figure 35: Fin-Type Heatsink Dimensions

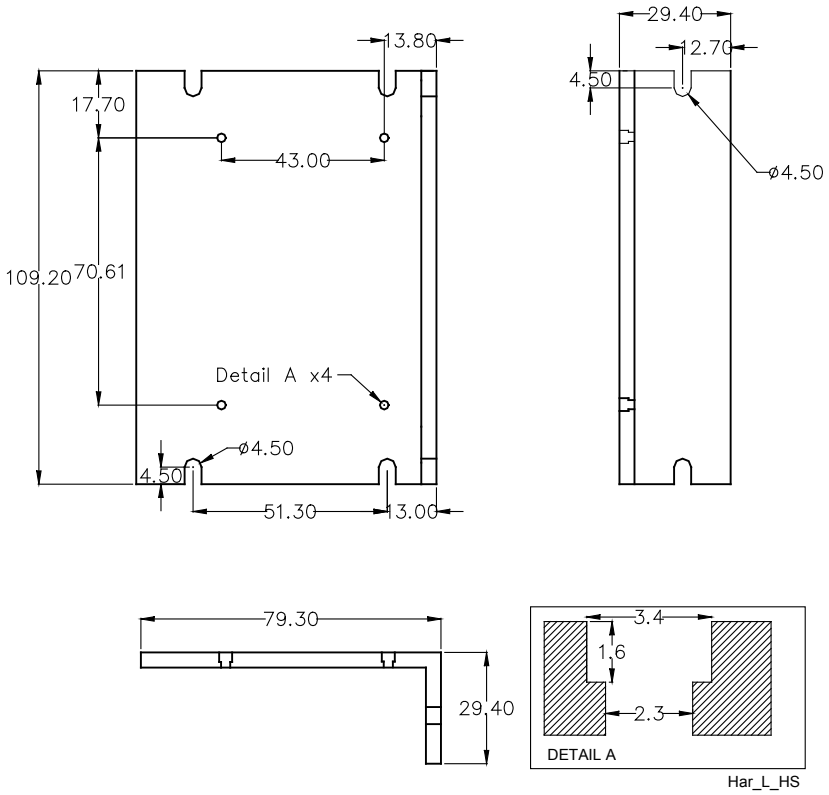


Figure 36: L-Shaped Heatsink Dimensions

4.13. Compliance with Standards

Specification	Details
Quality Assurance	
ISO 9001:2008	Quality Management
Design	
Approved **IEC/EN 61800-5-1, Safety**	Printed wiring for electronic equipment (clearance, creepage, spacing, conductors sizing, etc.)
MIL-HDBK- 217F	Reliability prediction of electronic equipment (rating, de-rating, stress, etc.)
• **UL 60950** • **IPC-D-275** • **IPC-SM-782** • **IPC-CM-770** • **UL 508C** • **UL 840**	Printed wiring for electronic equipment (clearance, creepage, spacing, conductors sizing, etc.)
In compliance with **VDE0160-7 (IEC 68)**	Type testing
Safety	
Recognized **UL 508C**	Power Conversion Equipment
In compliance with **UL 840**	Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment
In compliance with **UL 60950**	Safety of Information Technology Equipment Including Electrical Business Equipment
Approved **IEC/EN 61800-5-1, Safety**	Adjustable speed electrical power drive systems
In compliance with **EN 60204-1**	Low Voltage Directive 73/23/EEC

Specification	Details
EMC	
Approved **IEC/EN 61800-3, EMC**	Adjustable speed electrical power drive systems
In compliance with **EN 55011** Class A with **EN 61000-6-2**: Immunity for industrial environment, according to: **IEC 61000-4-2** / criteria B **IEC 61000-4-3** / criteria A **IEC 61000-4-4** / criteria B **IEC 61000-4-5** / criteria B **IEC 61000-4-6** / criteria A **IEC 61000-4-8** / criteria A **IEC 61000-4-11** / criteria B/C	Electromagnetic compatibility (EMC)
Workmanship	
In compliance with **IPC-A-610**, level 3	Acceptability of electronic assemblies
PCB	
In compliance with **IPC-A-600**, level 2	Acceptability of printed circuit boards
Packing	
In compliance with **EN 100015**	Protection of electrostatic sensitive devices
Environmental	
In compliance with **2002/96/EC**	Waste Electrical and Electronic Equipment regulations (WEEE) **Note:** Out-of-service Elmo drives should be sent to the nearest Elmo sales office.
In compliance with **2002/95/EC** (effective July 2006)	Restrictions on Application of Hazardous Substances in Electric and Electronic Equipment (RoHS)