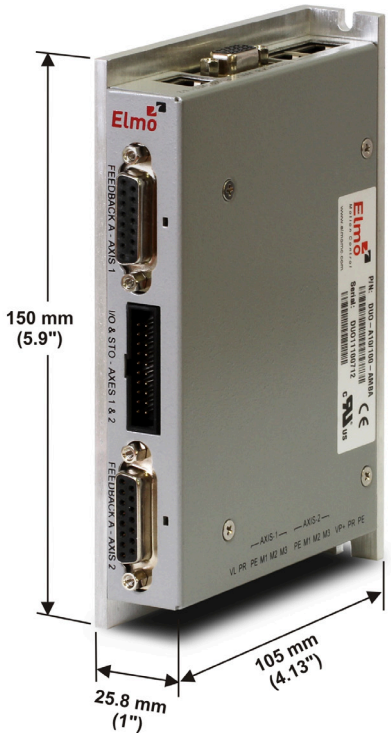
SimpIIQ Line

Duo
Digital Servo Drive
Installation Guide



October 2017 (Ver. 1.103)

Elmo
Motion Control

www.elmomc.com

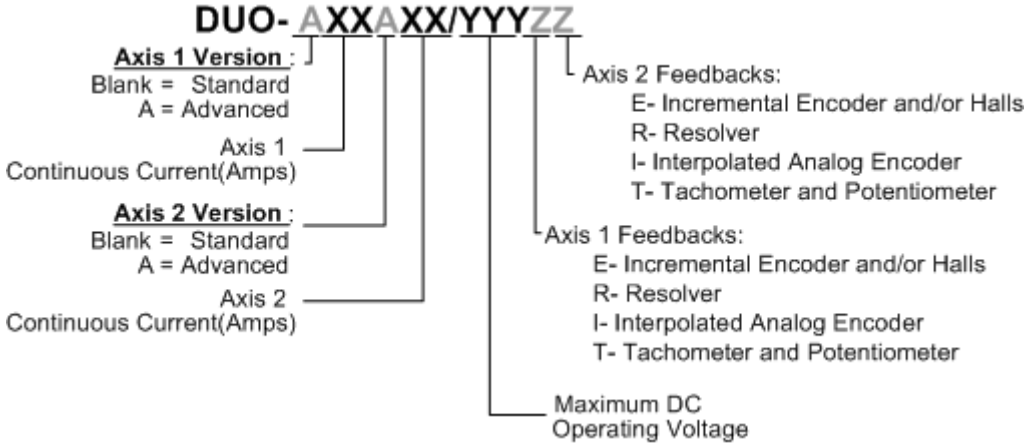
Notice

This guide is delivered subject to the following conditions and restrictions:

- This guide contains proprietary information belonging to Elmo Motion Control Ltd. Such information is supplied solely for the purpose of assisting users of the Duo servo drive in its installation.
- The text and graphics included in this manual are for the purpose of illustration and reference only. The specifications on which they are based are subject to change without notice.
- Elmo Motion Control and the Elmo Motion Control logo are trademarks of Elmo Motion Control Ltd.
- Information in this document is subject to change without notice.

Document no. MAN-DUOIG (Ver. 1.103)

Catalog Number



Cable Kit

Catalog number: CBL-BRDKIT-001 (can be ordered separately)

For further details, see the documentation for this cable kit in Chapter 5.

Revision History

Version		Details
1.0		Initial release
1.1	July 2012	Formatted according to the new template
1.101	Feb 2013	Added a caution and recommendation on the type of cleaning solution to use for the Elmo unit.
1.102	July 2014	General format changes
1.103	October 2017	Updated the Warranty Information section 1.5 and the part number label in section 3.2

Elmo Worldwide

Head Office

Elmo Motion Control Ltd.

60 Amal St., P.O. Box 3078, Petach Tikva 4951360
Israel

Tel: +972 (3) 929-2300 • Fax: +972 (3) 929-2322 • info-il@elmomc.com

North America

Elmo Motion Control Inc.

42 Technology Way, Nashua, NH 03060
USA

Tel: +1 (603) 821-9979 • Fax: +1 (603) 821-9943 • info-us@elmomc.com

Europe

Elmo Motion Control GmbH

Hermann-Schwer-Strasse 3, 78048 VS-Villingen
Germany

Tel: +49 (0) 7721-944 7120 • Fax: +49 (0) 7721-944 7130 • info-de@elmomc.com

China

Elmo Motion Control Technology (Shanghai) Co. Ltd.

Room 1414, Huawen Plaza, No. 999 Zhongshan West Road, Shanghai (200051)
China

Tel: +86-21-32516651 • Fax: +86-21-32516652 • info-asia@elmomc.com

Asia Pacific

Elmo Motion Control APAC Ltd.

B-601 Pangyo Innovalley, 621 Sampyeong-dong, Bundang-gu, Seongnam-si, Gyeonggi-do,

South Korea (463-400)

Tel: +82-31-698-2010 • Fax: +82-31-801-8078 • info-asia@elmomc.com

Table of Contents

Chapter 1: Safety Information

In order to achieve the optimum, safe operation of the Duo, 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 Duo 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 Duo 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 or electrical damage, never connect/disconnect any plug or cable from 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 Duo from all voltage sources before it is opened for servicing.
- The Duo contains grounding conduits for electric current protection. Any disruption to these conduits may cause the instrument to become hot (live) and dangerous.
- 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 Duo contains hot surfaces and electrically-charged components during operation.
- The maximum AC/DC power supply connected to the instrument must comply with the parameters outlined in this guide. Furthermore, the power supply must be isolated from hazardous live voltages using reinforced or double insulation in accordance to approved safety standards.
- When connecting the Duo to an approved 12 to 95 VDC (8.5 to 67 VAC) auxiliary power supply, connect it through a line that is isolated from hazardous live voltages using reinforced or double insulation in accordance with approved safety standards.
- Before switching on the Duo, 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 Duo 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 Duo 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 Duo 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 Duo 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 Duo 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 Duo and the steps for its wiring, installation and power-up. Following these guidelines ensures maximum functionality of the product and the system to which it is connected.

2.1. Product Description

The Duo series of servo drives enhances Elmo's range of digital servo drives, recognized for having the highest power density and intelligence. The Duo is a highly compact integrated solution containing two drives in a single package. The solution operates under a single power supply and is designed for applications with up to two axes.

The Duo integrates Elmo's advanced "Elmo First Control" technology, which contributes to the product's excellent control performance, wide range of functionalities and high efficiency and reliability. The solution includes two fully separated digital motion controllers that feature:

- CANopen-based networking operating simultaneously via RS-232 and CAN DS 301, DSP 305, DSP 402 communications and featuring a third-generation programming environment
- Current, velocity and position control loops including PT and PVT
- Commutation types
- Position feedbacks

The benefits are high dynamics and increased precision for dual axis automated machines such as robots, feeders, up- and down-loaders, conveyor belts and production lines.

Power to the various Duo models is provided by a 0 to 95 VDC source. A "smart" control-supply algorithm enables the Duo to operate with only one power supply and there is no need for an auxiliary power supply for the logic.

If backup functionality is required for storing control parameters in case of power-loss, an external 12 to 95 VDC supply should be connected (via the +VL terminal on the Duo) providing maximum flexibility and backup functionality when needed.

Note: This backup power supply can operate from any voltage source within the range from 12 to 95 VDC. This is much more flexible than a standard 24 VDC power supply requirement.

The Duo series fully complies with all relevant **safety** and **EMC** regulations.

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 rate four times current loop sample time
- Fast event capturing inputs

2.2.4. Advanced Position Control *(in 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, Duo users can select from two communication options:

- RS232 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) per second
- Digital Halls – up to 2 KHz
- Incremental Encoder with Digital Halls for commutation – up to 20 Mega-Counts per second for encoder
- Interpolated Analog (Sine/Cosine) Encoder – up to 250 KHz (analog signal)
  - Internal Interpolation - up to x4096
  - Automatic Correction of amplitude mismatch, phase mismatch, signals offset
  - Auxiliary emulated, unbuffered, single-ended, encoder output
- Resolver
  - Programmable 10 to 15 bit resolution
  - Up to 512 Revolution Per Second (RPS)
  - Auxiliary emulated, unbuffered, single-ended, encoder output
- Tachometer, Potentiometer
- Elmo drives provide supply voltage for all the feedback options

2.2.7. Fault Protection

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

- Software error handling
- Status reporting for a large number of possible fault conditions
- Protection against conditions such as excessive temperature, 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. How to Use this Guide

In order to install and operate your Elmo Duo, 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 Duo.
- Chapters 4 and 5 list all the drive ratings and specifications as well as information on the relevant cables.

Upon completing the instructions in this guide, your Duo 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.

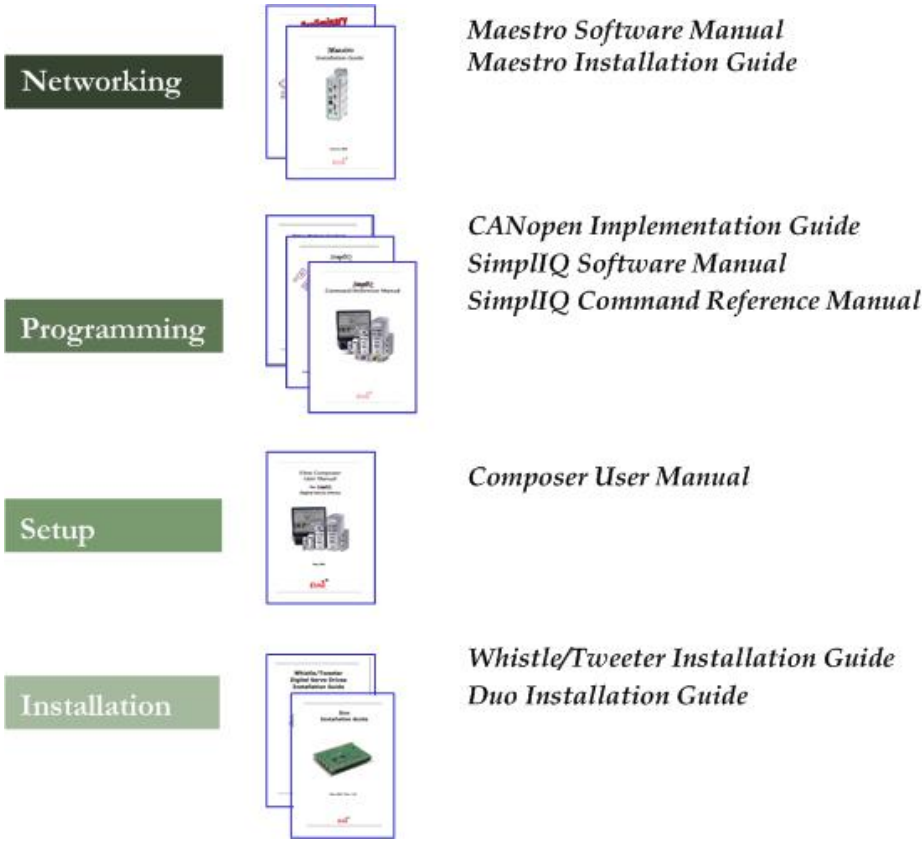


Figure 1: Elmo Digital Servo Drive Documentation Hierarchy

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

- The Duo Installation Guide contains information about how to use the Duo and Cable Kit
- 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 Duo motion controllers
- The *SimplIQ Software Manual,* which describes the comprehensive software used with the Duos

Chapter 3: Installation

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

3.1. Site Requirements

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

Feature	Value
Ambient operating temperature	0° to 40°C (32° 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 Whistle on the Duo dissipates its heat by convection. The maximum operating ambient temperature of 0° to 40°C (32° to 104°F) must not be exceeded. Refer to the Heat Dissipation section of the *Whistle Installation Guide* for more information.

3.2. Unpacking the Drive Components

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

- The Duo.
- The Composer software and software manual.

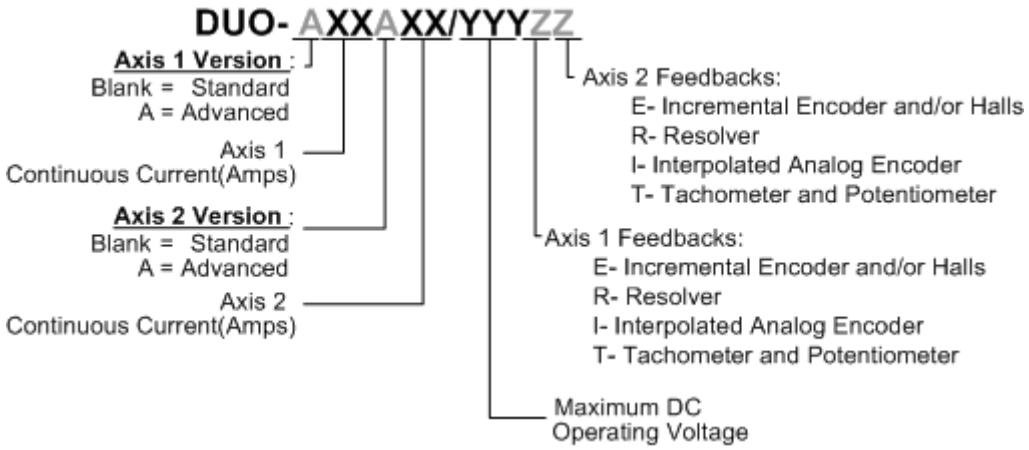
The Duo is shipped in a cardboard box with Styrofoam protection.

To unpack the Duo:

1. Carefully remove the Duo from the box and the Styrofoam.
2. Check the Duo 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 Duo.
3. To ensure that the Duo you have unpacked is the appropriate type for your requirements, locate the part number sticker on the side of the Duo. It looks like this:

DUO0001B

The part number at the top gives the type designation as follows:



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

3.3. Mounting the Duo

The Duo has been designed for two standard mounting options:

- Wall Mount, along the back (can also be mounted horizontally on a metal surface)
- Book Shelf, along the side

M4 round head screws, one through each opening in the heat sink, are used to mount the Duo (see the diagram below).

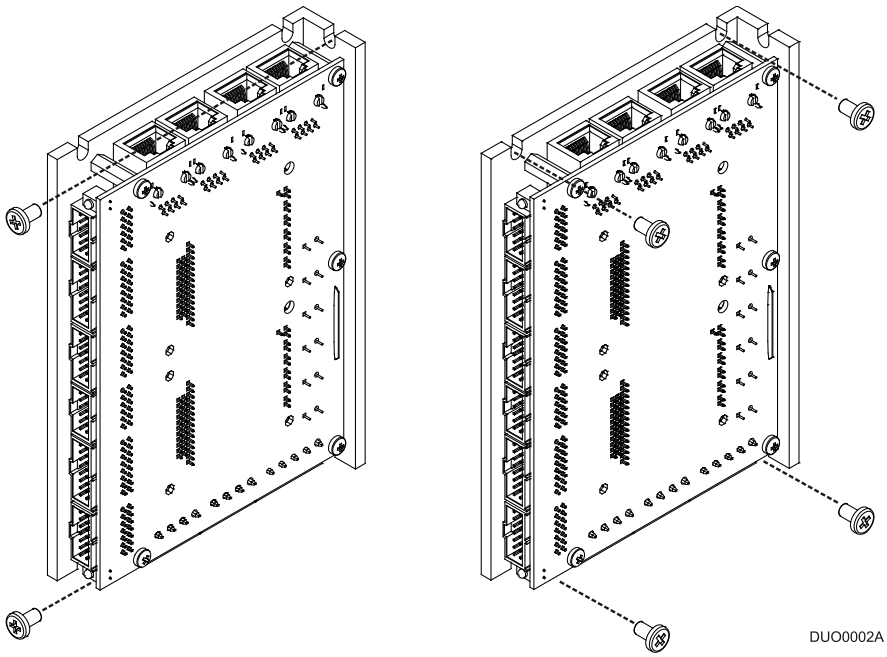


Figure 2: Mounting the Duo

3.4. Connecting the Cables

3.4.1. Wiring the Duo

Once the Duo 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 Duo.

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

- Use twisted pair shielded cables for control, Feedback and communication connections. For best results, the cable should have an aluminum foil shield covered by copper braid, and should contain a drain wire.

  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.

- 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 26 or 28 AWG wire for control and Feedback cables is satisfactory although 26 AWG is recommended.

- 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 Duo:

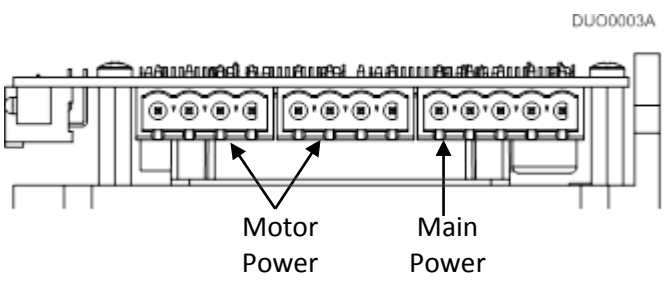
Type	Function	Connector Location
Main Power	VL, VP+, PR, PR, PE	
Motor Power	PE, M1, M2, M3	

Table 1: Connectors at the Power side of the Duo

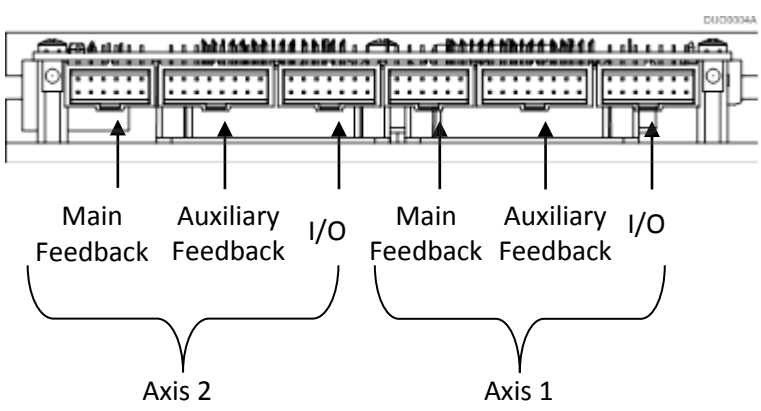
Type	Function	Connector Location
Main Feedback	Feedback	
I/O	I/O	
Auxiliary Feedback	Auxiliary Feedback	

Table 2: Connectors at the Feedback side of the Duo

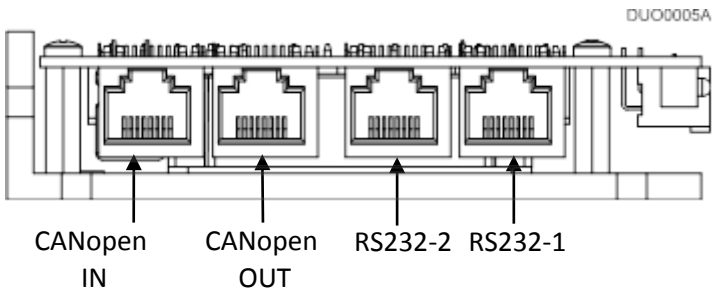
Type	Function	Connector Location
CAN	CAN IN	
CAN	CAN OUT	
RS232	RS232-1 RS232-2	

Table 3: Connectors at the Communication side of the Duo

3.5. Duo Connector Types

The Duo has 13 connectors.

Type	Qty Conn.	On Board Connector
Main Power		Phoenix 5-pin Header P/N:MSTBA 2.5HC/5-G
Motor Power	2	Phoenix 4-pin Header P/N:MSTBA 2.5/4G-5.08
Main Feedback	2	12-Pin Molex Header P/N:90130-3212
I/O	2	14-Pin Molex Header P/N:90130-3214
Auxiliary Feedback	2	16-Pin Molex Header P/N:90130-3216
CAN Comm.	2	8-Pin RJ-45 Socket
RS232 Comm.	2	8-Pin RJ-45 Socket
Connector Location		

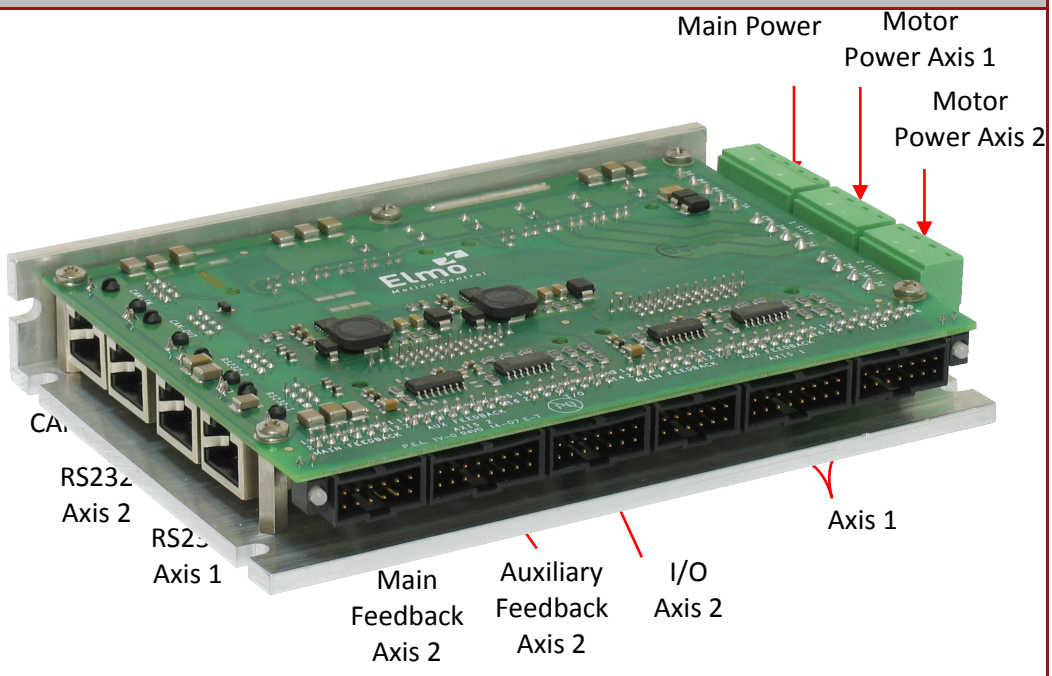


Table 4: Connectors Location

3.6. Hardware Requirements

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

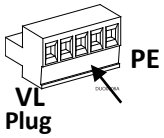
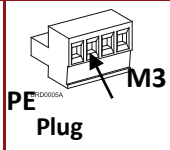
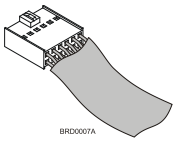
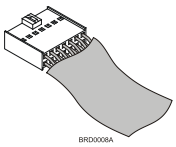
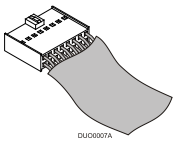
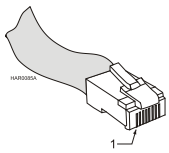
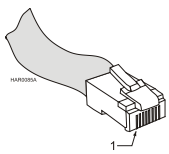
Component	Qty Conn.	Mating Connector	Function	Described in section	Cable Drawing
Main Power	1	Phoenix 5-pin Plug P/N:MSTBT 2.5HC/5-ST	VL, VP+, PR, PR, PE		
Motor Power	2	Phoenix 4-pin Plug P/N:MSTBT 2.5/4-ST-5.08	PE, M1, M2, M3		
Main Feedback	2	12-Pin Molex Plug P/N:90142-0012 Pin P/N: 90119-2121	Feedback	5.3	
I/O	2	14-Pin Molex Plug P/N:90142-0014 Pin P/N: 90119-2121	I/O	5.5	
Auxiliary Feedback	2	16-Pin Molex Plug P/N:90142-0016 Pin P/N: 90119-2121	Auxiliary Feedback	5.4	
RS232 Comm.	2	8-Pin RJ-45 Plug	RS232-1 RS232-2	5.6.1	
CAN Comm.	2	8-Pin RJ-45 Plug	CAN IN CAN OUT	5.6.2	

Table 5: Connector Cross Reference

3.7. Duo Connection Diagram

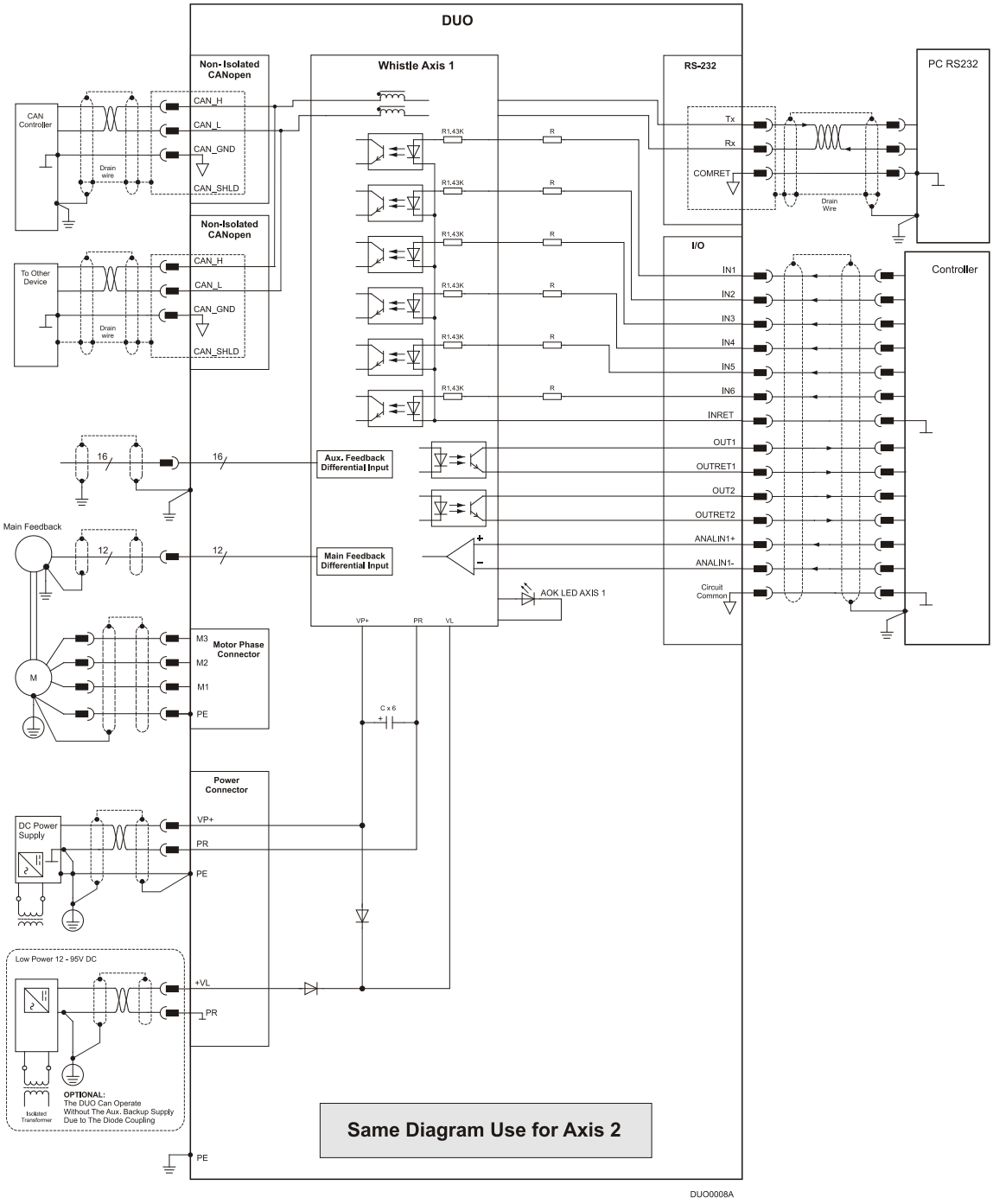


Figure 3: Duo Connection Diagram

3.8. The Main Power and Motor Power Connectors

The Duo receives power from main and auxiliary supplies and delivers power to the motor.

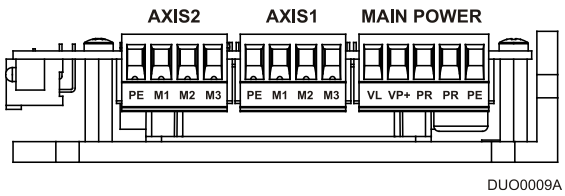
Pin	Function	Cable		Pin Positions
PE	Protective earth	Power		 DUO0009A
PR	Power return	Power		
PR	Aux. Supply Input Return	Auxiliary		
VP+	Pos. Power input	Power		
VL	Aux. Supply Input	Auxiliary		
		AC Motor Cable	**DC Motor Cable**	
M3	Motor phase	Motor	Motor	
M2	Motor phase	Motor	Motor	
M1	Motor phase	Motor	N/C	
PE	Protective earth	Motor	Motor	

Table 6: Main Power and Motors Connections

3.8.1. Connecting Motor Power

Connect the motor power cable to the M1, M2, M3 and PE terminals of the relevant axis. The phase connection order is arbitrary because the Composer will establish the proper commutation automatically during setup. If several motor/drive combinations are designed to operate in an identical manner, it is recommended to download the program into all the drives and connecting them in the same way.

Notes for connecting the motor cables:

- For the greatest 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.
- Be sure that the motor chassis is properly grounded.

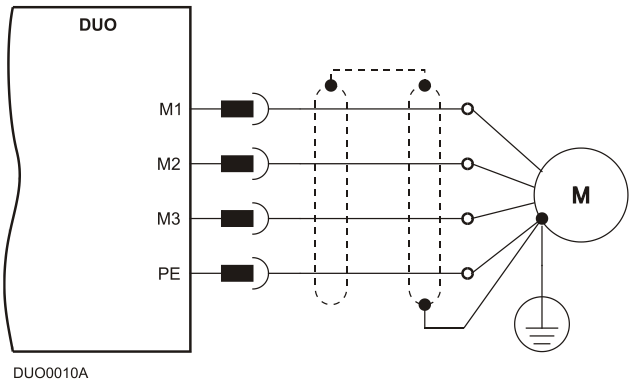


Figure 4: AC Motor Power Connection Diagram for each AXIS.

3.8.2. Connecting Main Power

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

Notes for connecting the DC power supply:

- The source of the 0 to 95 VDC Power Supply must be isolated.
- For the greatest immunity, it is highly recommended to use twisted and shielded 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.
- Before applying power, first verify the polarity of the connection.

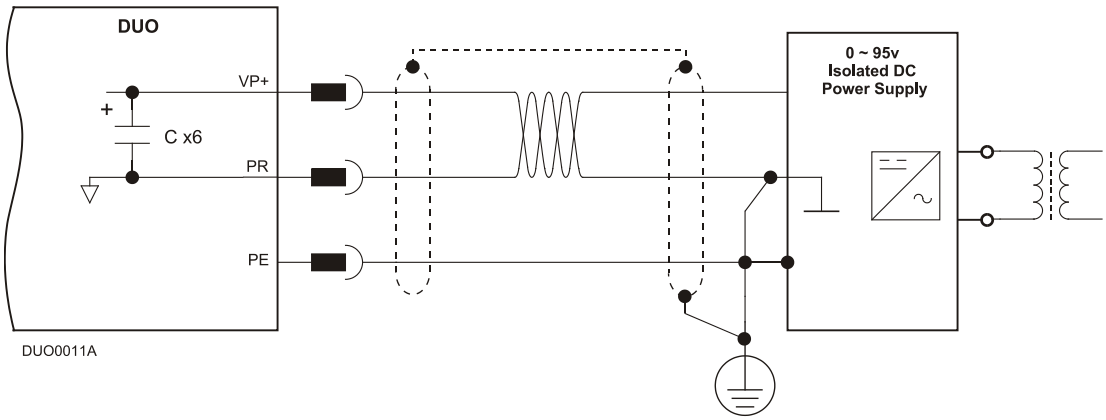


Figure 5: Main Power DC Supply Connection Diagram

3.8.3. Low-Power Auxiliary Supply (optional)

Notes for 12 to 95 VDC Auxiliary Supply connections:

- The source of the 12 to 95 VDC Auxiliary Supply must be isolated from the Main.
- For safety reasons, connect the return (common) of the Auxiliary Supply source to the closest ground near the Auxiliary Supply source.
- Connect the cable shield to the closest ground near the Auxiliary Supply source.
- Before applying power, first verify the polarity of the connection.

Caution:
Power to each Whistle and motor must come from the Main Supply and **NOT** from the Auxiliary Supply.

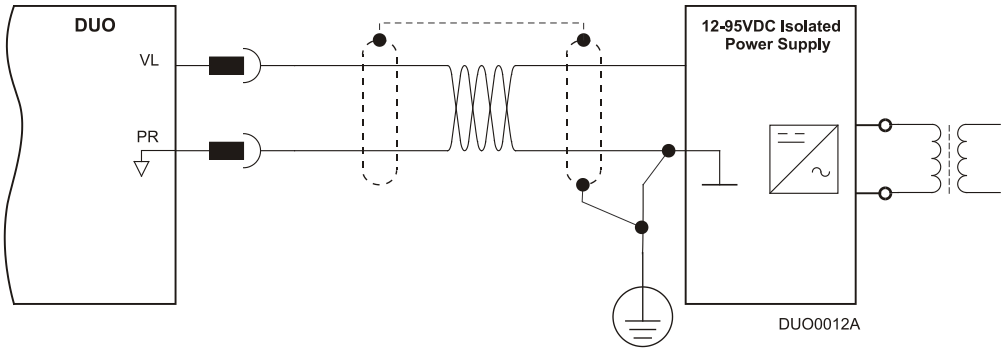


Figure 6: Auxiliary Supply Connection Diagram

The backup functionality can be used for storing control parameters in case of power-loss, providing maximum flexibility and backup functionality when needed.

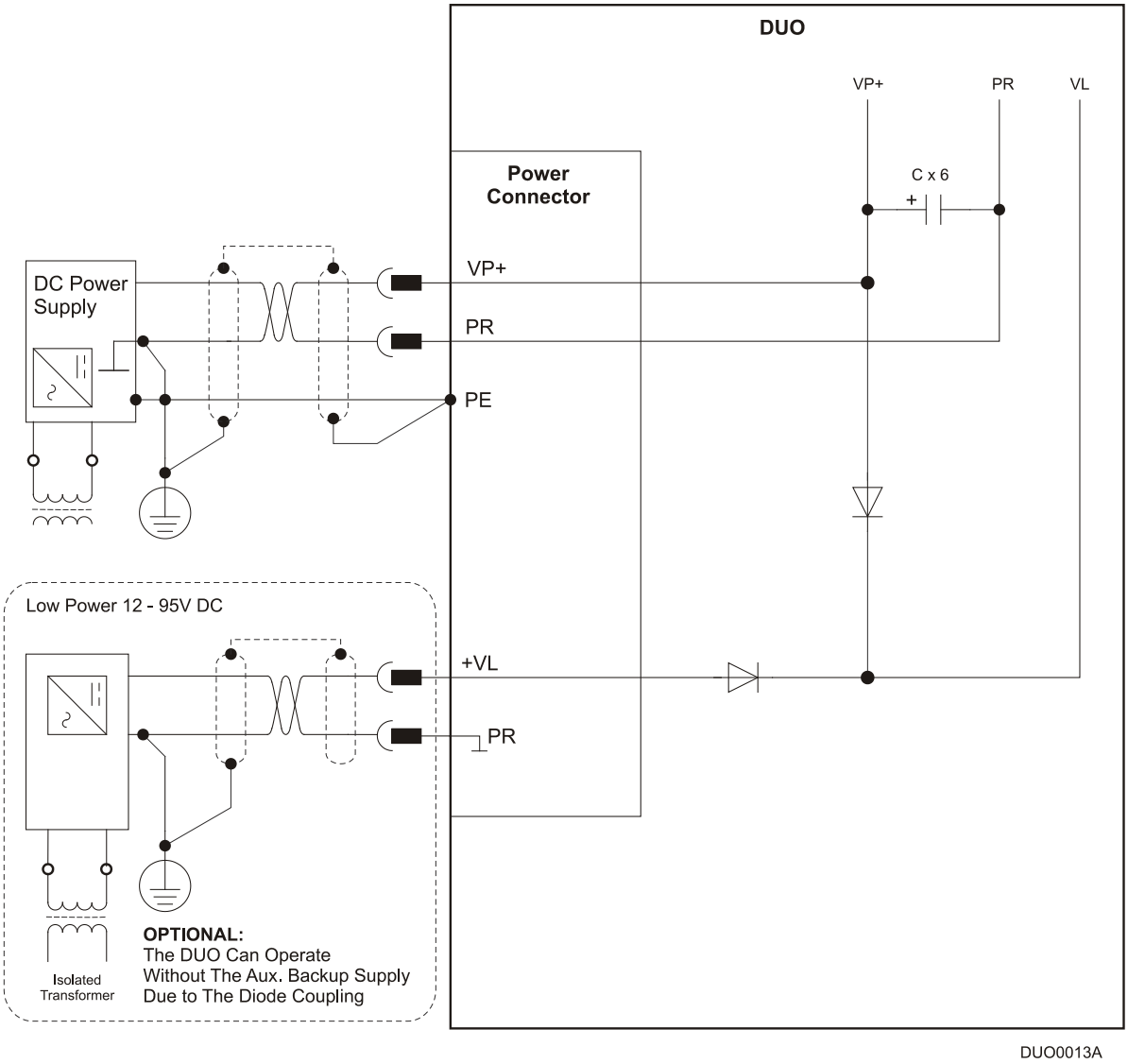


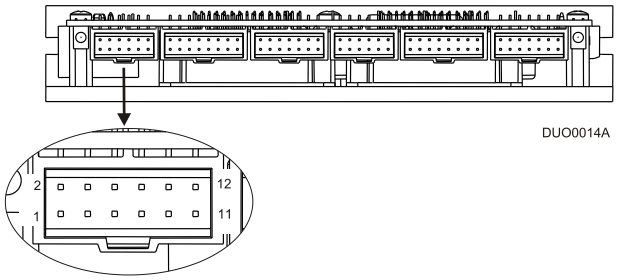
Figure 7: Shared Supply Connection Diagram

3.9. Main Feedback

The Main Feedback port is used to transfer Feedback data from the motor to the drive.

The Duo accepts the following as a Main Feedback mechanism:

- Incremental encoder only
- Incremental encoder with digital hall sensors
- Digital hall sensors only
- Interpolated analog (sine/cosine) encoder (option)
- Resolver (option)
- Tachometer and potentiometer (option)
- Analog Halls



The Main Feedback port on the Duo has a 12-pin Molex Header plug.

	Incremental Encoder		Interpolated Analog Encoder		Resolver		Tachometer and Potentiometer	
	DUO-XX/YYYE		DUO-XX/YYYI		DUO-XX/YYYR		DUO-XX/YYYT	
Pin	Signal	Function	Signal	Function	Signal	Function	Signal	Function
1	+5V	Encoder/Hall +5V supply	+5V	Encoder/Hall +5V supply	+5V	Encoder/Hall +5V supply	+5V	Encoder/Hall +5V supply
2	SUPRET	Supply return	SUPRET	Supply return	SUPRET	Supply return	SUPRET	Supply return
3	CHA	Channel A	A+	Sine A	S1	Sine A	Tac 1+	Tacho Input 1 Pos. (20 V max)
4	CHA-	Channel A complement	A-	Sine A complement	S3	Sine A complement	Tac 1-	Tacho Input 1 Neg. (20 V max)
5	CHB	Channel B	B+	Cosine B	S2	Cosine B	Tac 2+	Tacho Input 2 Pos. (50 V max)
6	CHB-	Channel B complement	B-	Cosine B complement	S4	Cosine B complement	Tac 2-	Tacho Input 2 Neg. (50 V max)
7	INDEX	Index	R+	Reference	R1	Vref f=1/TS, 50 mA Max.	POT	Potentiometer Input
8	INDEX-	Index complement	R-	Reference complement	R2	Vref complement f= 1/TS, 50 mA Max	NC	-
9	HA	Hall sensor A input	HA	Hall sensor A input	NC	-	HA	Hall sensor A input
10	HB	Hall sensor B input	HB	Hall sensor B input	NC	-	HB	Hall sensor B input
11	HC	Hall sensor C input	HC	Hall sensor C input	NC	-	HC	Hall sensor C input
12	SUPRET	Supply return	SUPRET	Supply return	SUPRET	Supply return	SUPRET	Supply return

Table 7: Main Feedback Cable Pin Assignment for Each Axis

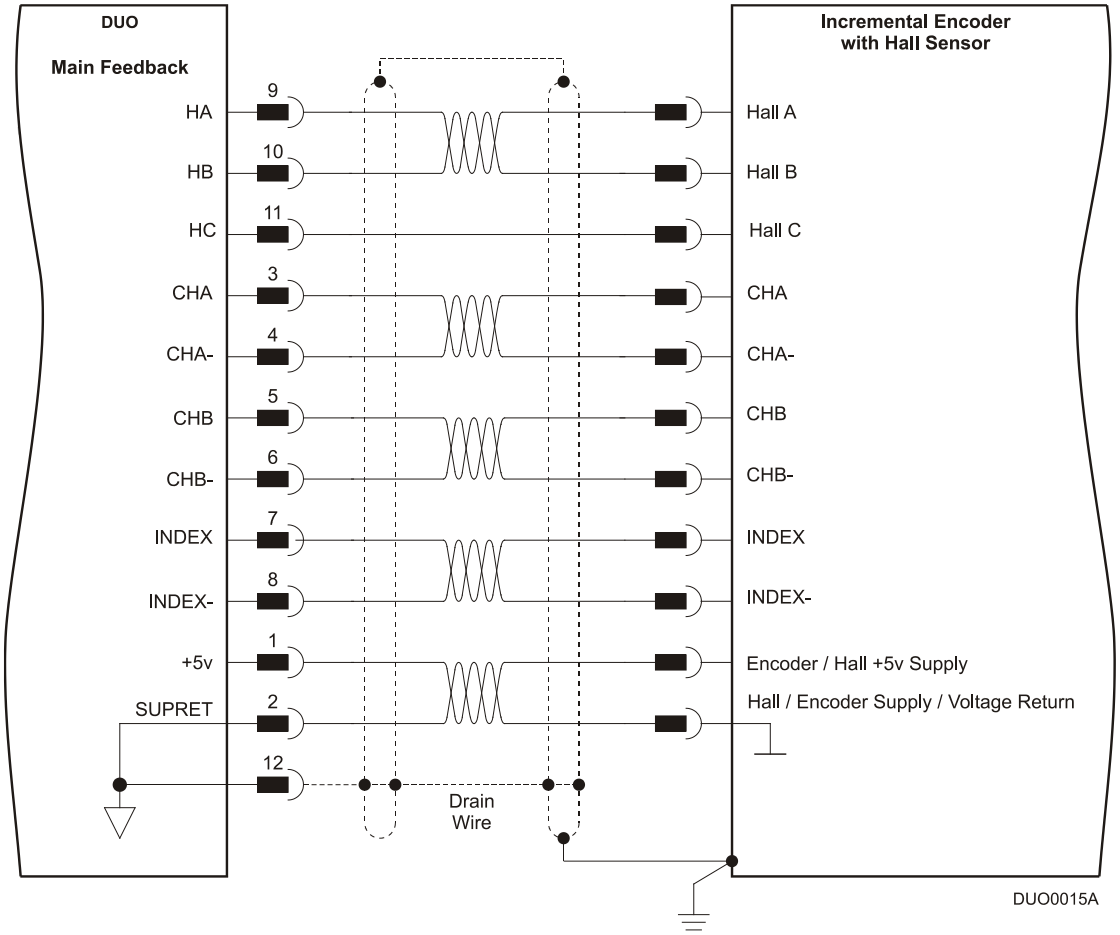


Figure 8: Main Feedback- Incremental Encoder with Digital Halls Sensors Connection Diagram

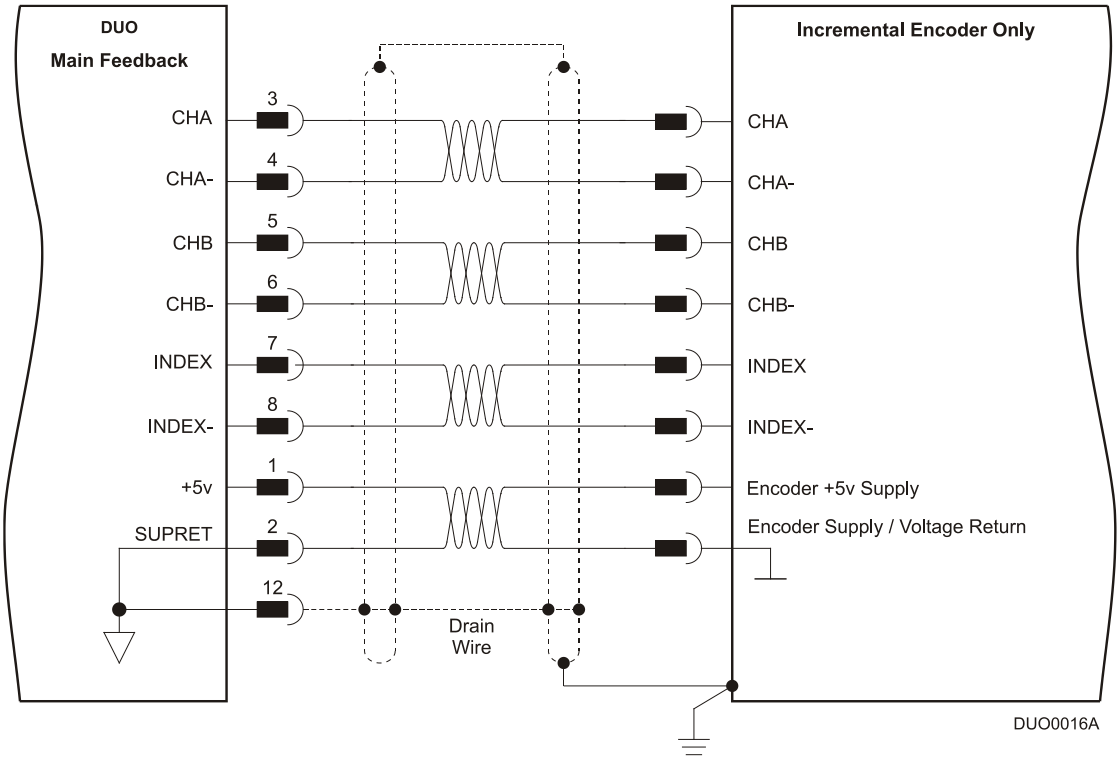


Figure 9: Main Feedback- Incremental Encoder Only Connection Diagram

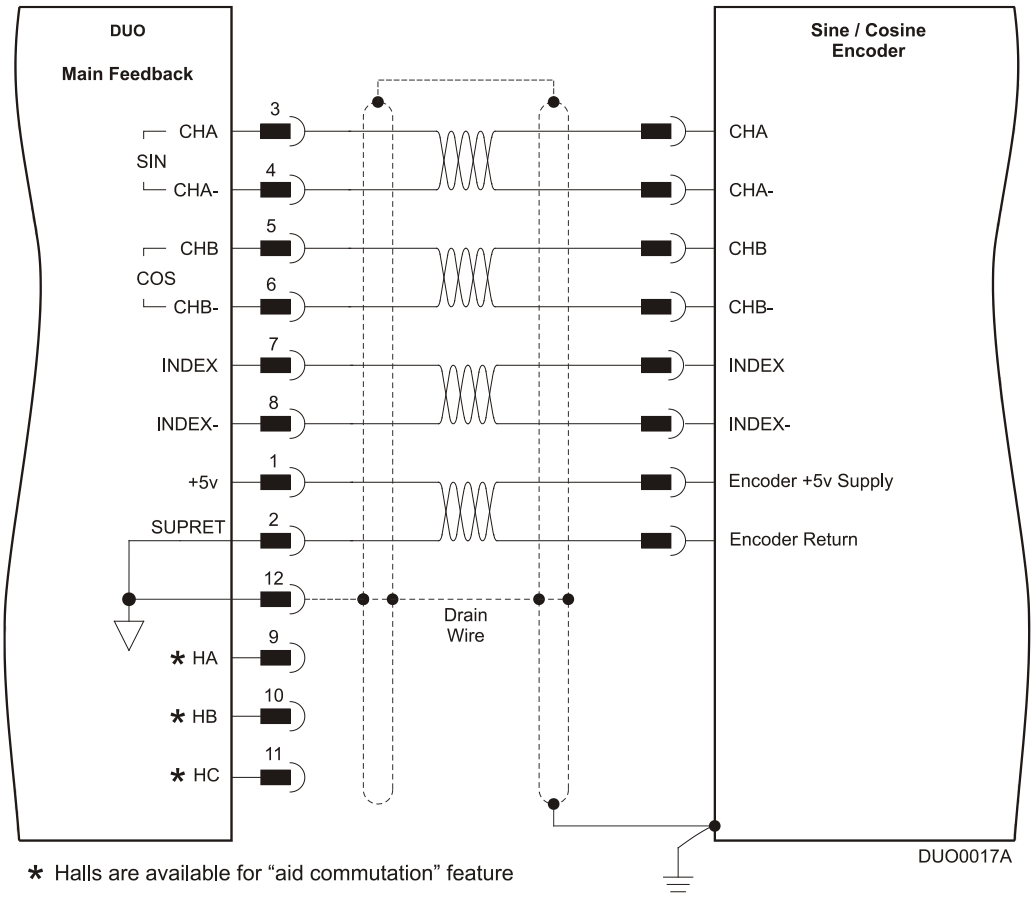


Figure 10: Main Feedback – Interpolated Analog (Sine/Cosine) Encoder Connection Diagram

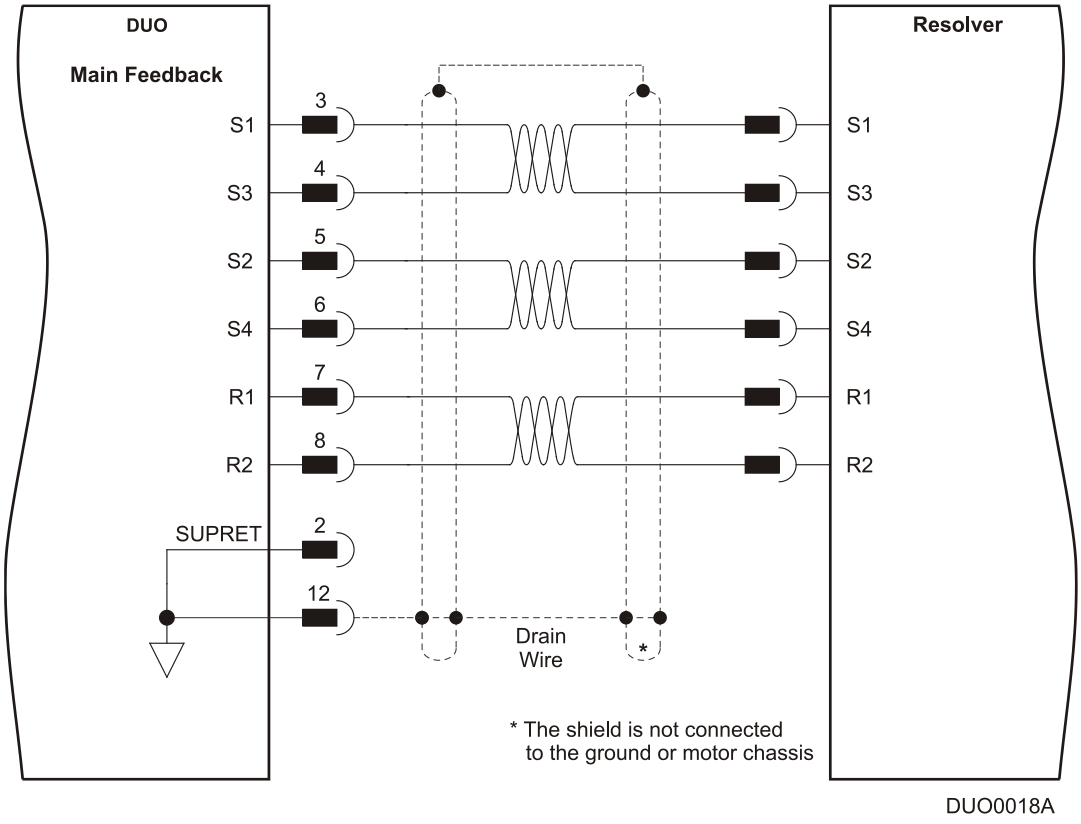


Figure 11: Main Feedback– Resolver Connection Diagram

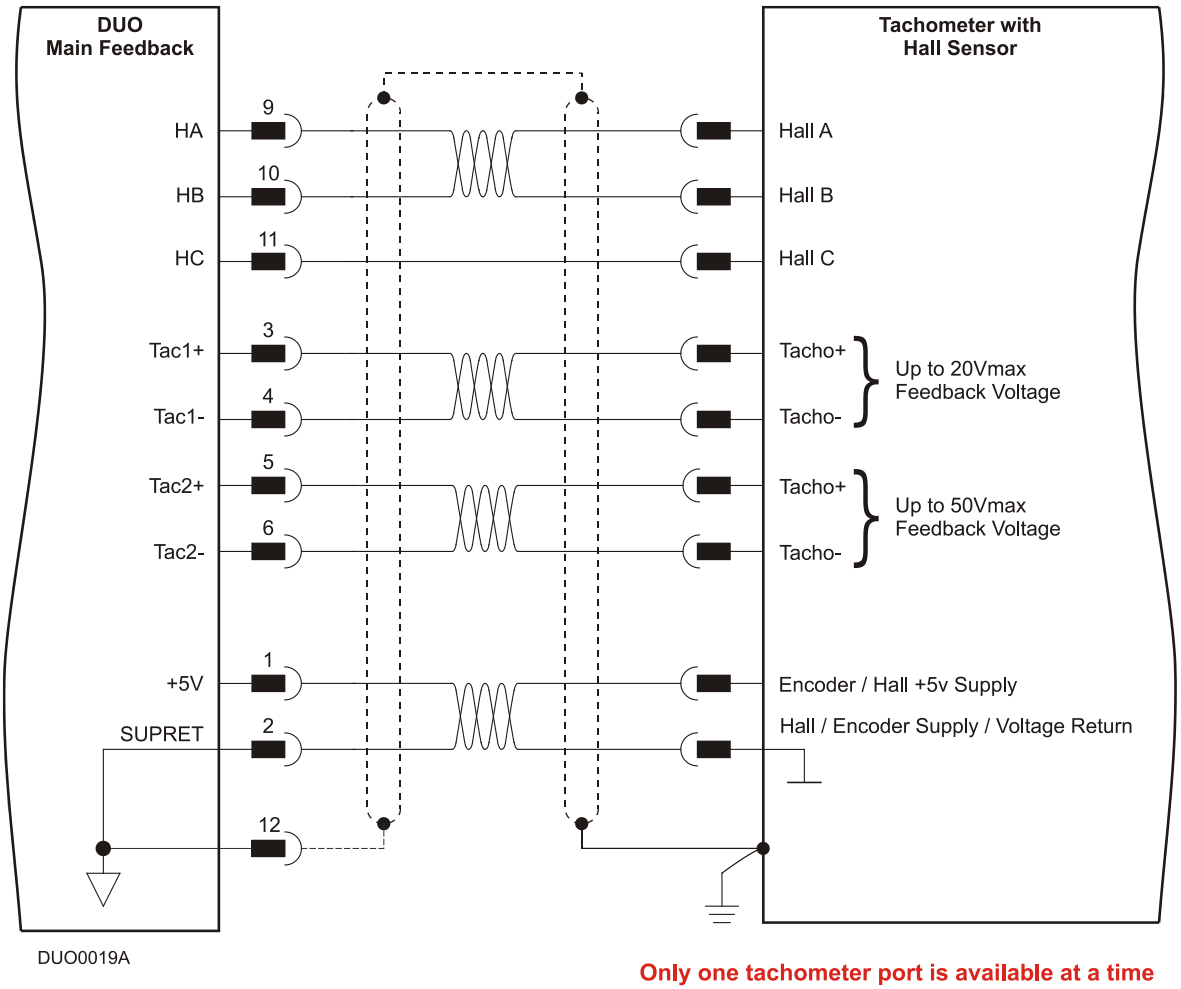


Figure 12: Main Feedback – Tachometer Feedback with Digital Hall Sensor Connection Diagram for Brushless Motors

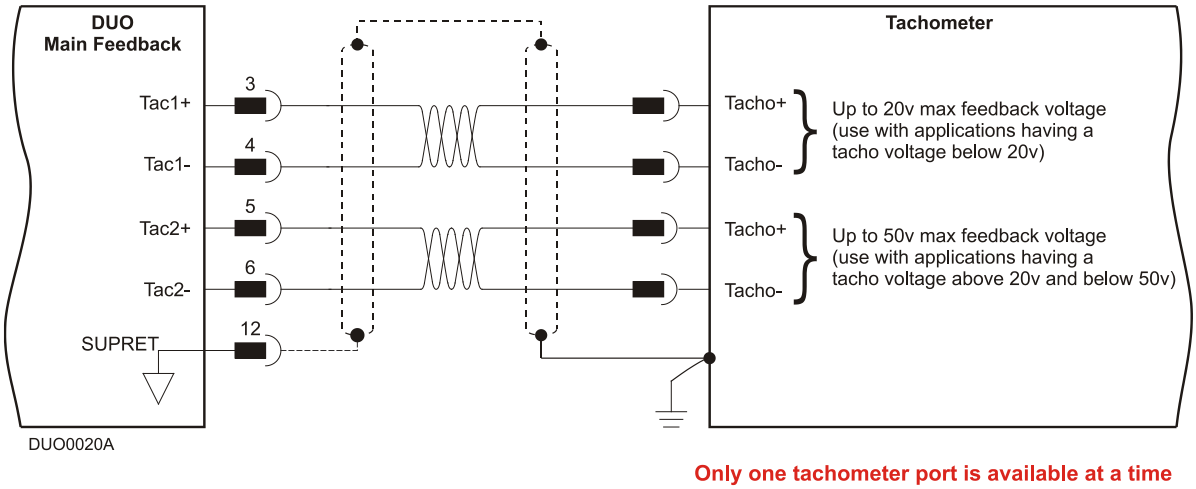


Figure 13: Main Feedback – Tachometer Feedback Connection Diagram for Brush Motors

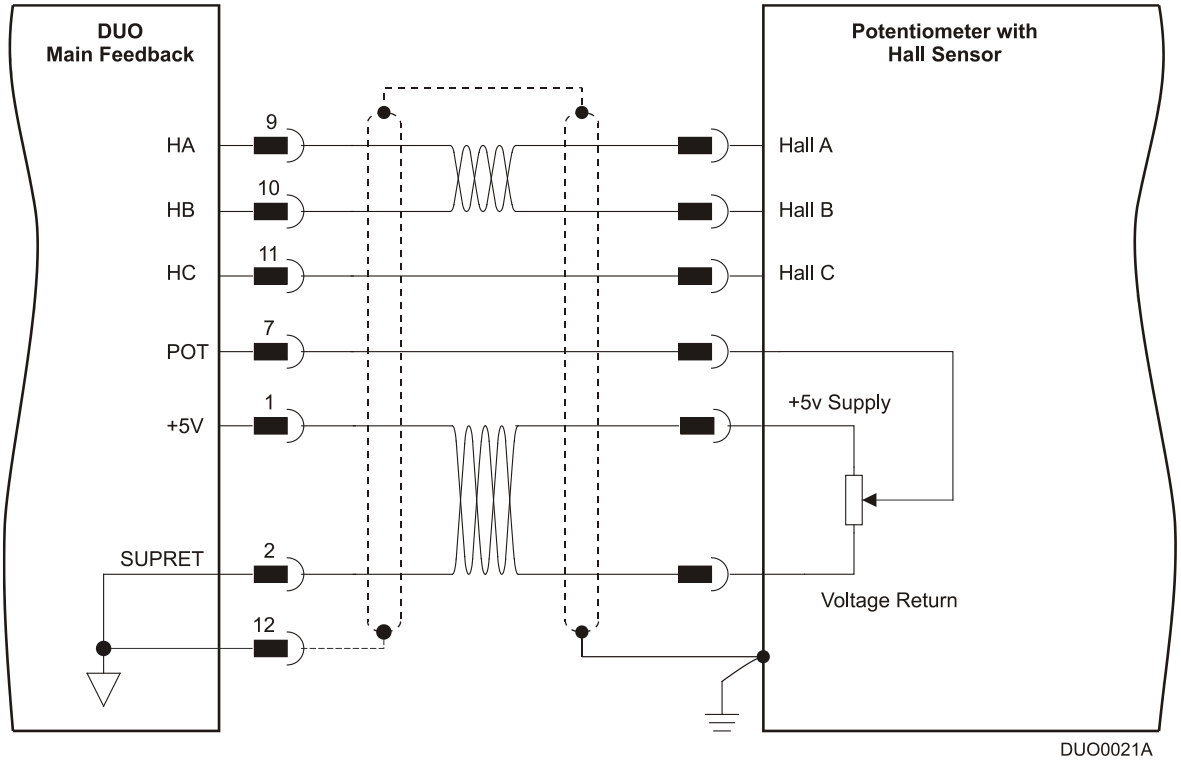


Figure 14: Main Feedback – Potentiometer Feedback with Digital Hall Sensor Connection Diagram for Brushless Motors

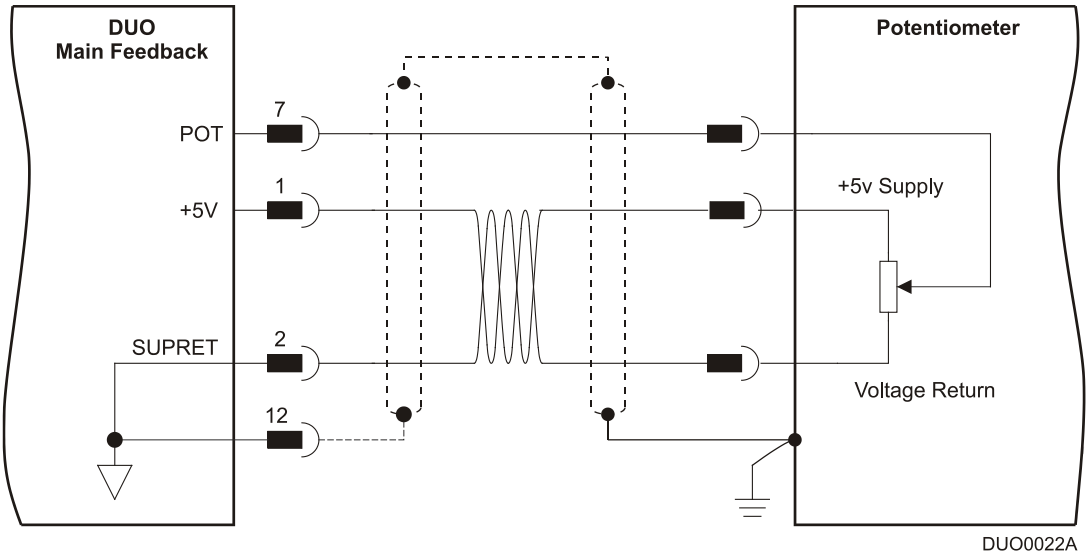


Figure 15: Main Feedback –
Potentiometer Feedback Connection Diagram for Brush Motors and Voice Coils

3.10. Auxiliary Feedback (Bi-directional)

When using one of the Auxiliary Feedback options, the relevant functionality of the Auxiliary Feedback's ports are software selected for that option. Refer to the *SimplIQ Command Reference Manual* for detailed information about Auxiliary Feedback setup.

The Auxiliary Feedback connector has two ports – B1 and B2.

- **Port B1** has three pairs of differential buffered inputs
- **Port B2** has three pairs of differential buffered outputs

There are two modes of operation for this interface:

- **Mode 1 (Composer Command: YA[4]=4) see Section 3.10.2**

  When the Auxiliary port of the Whistle is set by the software to act as an emulated encoder output (this is practical only when using a Resolver or Analog Encoder as the Main Feedback):

  - B1 input becomes inactive.
  - B2 presents emulated differential buffered encoder output signals of the Main Feedback.

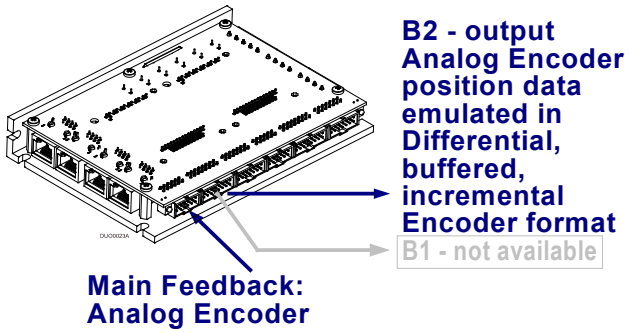
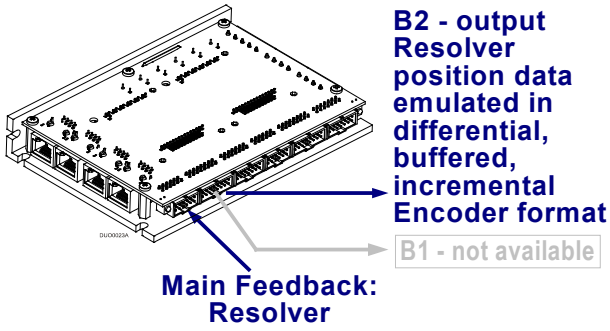
- **Mode 2 (Composer Command: YA[4]=2 or YA[4]=0) see Sections 3.10.3 and 3.10.4**

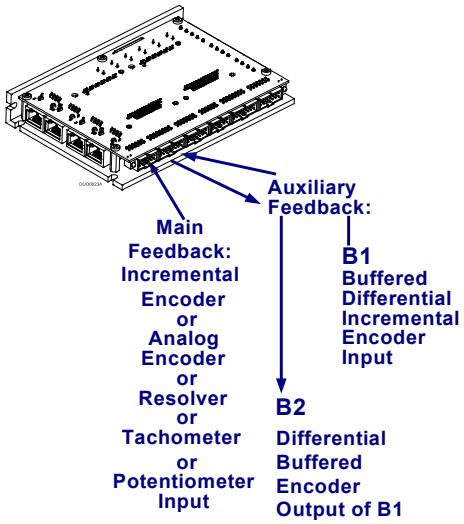
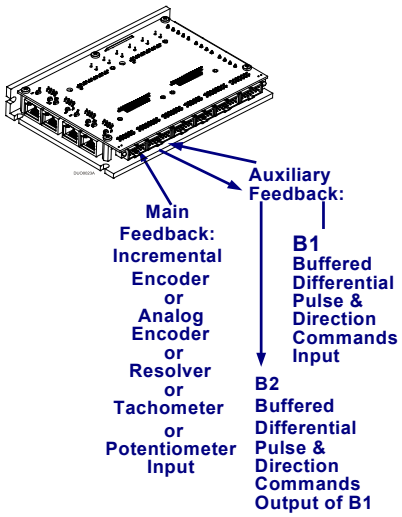
  When the Auxiliary port of the Whistle is set by software to act as an input:

  - B1 becomes an active differential buffered input.
  - B2 presents differential buffered encoder output signals of B1.

3.10.1. Main and Auxiliary Feedback Combinations

The Main Feedback is always used in motion control devices whereas Auxiliary Feedback is often, but not always used. The Auxiliary Feedback connector has two ports (B1 and B2). When used in combination with Main Feedback, the Auxiliary Feedback can be set, by software, as follows:

Main Feedback	Auxiliary Feedback: Output
Software Setting	**YA[4] = 4** (Auxiliary Feedback: output)
Incremental Encoder Input	**N.A.**
Interpolated Analog (Sine/Cosine) Encoder Input	✶ 
Resolver Input	✸ 
Potentiometer Tachometer Input	**N.A.**
Typical Applications	✶ Analog Encoder applications where position data is required, in the Encoder's quadrature format, for other purposes such as position controllers and/or other drives. ✸ Resolver applications where position data is required in the Encoder's quadrature format, for other purposes such as position controllers and/or other drives.

Main Feedback	Auxiliary Feedback: Input	
Software Setting	**YA[4] = 2** (Auxiliary Feedback: input)	**YA[4] = 0** (Auxiliary Feedback: input)
Incremental Encoder Input **Interpolated Analog (Sine/Cosine) Encoder Input** **Resolver Input** **Potentiometer Tachometer Input**		
Typical Applications	Any application where two Feedbacks are used by the drive. The Auxiliary Feedback port serves as an input for the Auxiliary incremental encoder. For applications such as Follower, ECAM, or Dual Loop.	Any application where two Feedbacks are used by the drive. The Auxiliary Feedback port serves as an input for Pulse & Direction Commands.

3.10.2. Auxiliary Feedback – Emulated, Differential Buffered Encoder Output Option (YA[4]=4)

The Auxiliary Feedback's B2 port can provide **emulated encoder signals** to other controllers or drives. This option can be used when:

- A Resolver or Analog Encoder is used as a Main Feedback device.
- The Whistle is used as a current amplifier to provide position data to the position controller.
- The Whistle is used in velocity mode, to provide position data to the position controller.
- The Whistle is used as a master in Follower or ECAM mode.

Below are the signals on the Auxiliary Feedback ports when the Whistle Auxiliary Feedback port is set up for emulated output of the Main Feedback device (Resolver or Analog Incremental Encoder only).

The Auxiliary Feedback on the Duo has a 16-pin Molex Header plug.

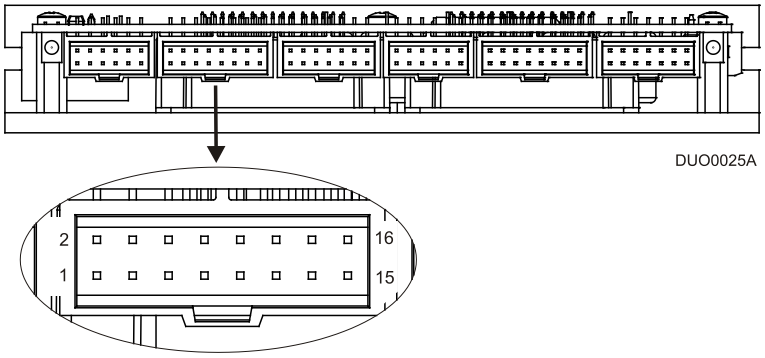
Port	Pin	Signal	Function
PWR	1	+5V	Encoder supply voltage
PWR	2	COMRET	Common return
B1	3	NA	When YA[4]=4 the B1 port is not available
B1	4	NA	When YA[4]=4 the B1 port is not available
B1	5	NA	When YA[4]=4 the B1 port is not available
B1	6	NA	When YA[4]=4 the B1 port is not available
B1	7	NA	When YA[4]=4 the B1 port is not available
B1	8	NA	When YA[4]=4 the B1 port is not available
B2	9	CHAO	Buffered Channel A output
B2	10	CHAO-	Buffered Channel A complement output
B2	11	CHBO	Buffered channel B output
B2	12	CHBO-	Buffered channel B complement output
B2	13	INDEXO	Buffered Index output
B2	14	INDEXO-	Buffered Index complement output
PWR	15	+5V	Encoder supply voltage
PWR	16	COMRET	Common return
Pin Positions			
			

Table 8: Emulated Encoder Output on the Auxiliary Feedback Port B2 - Pin Assignments

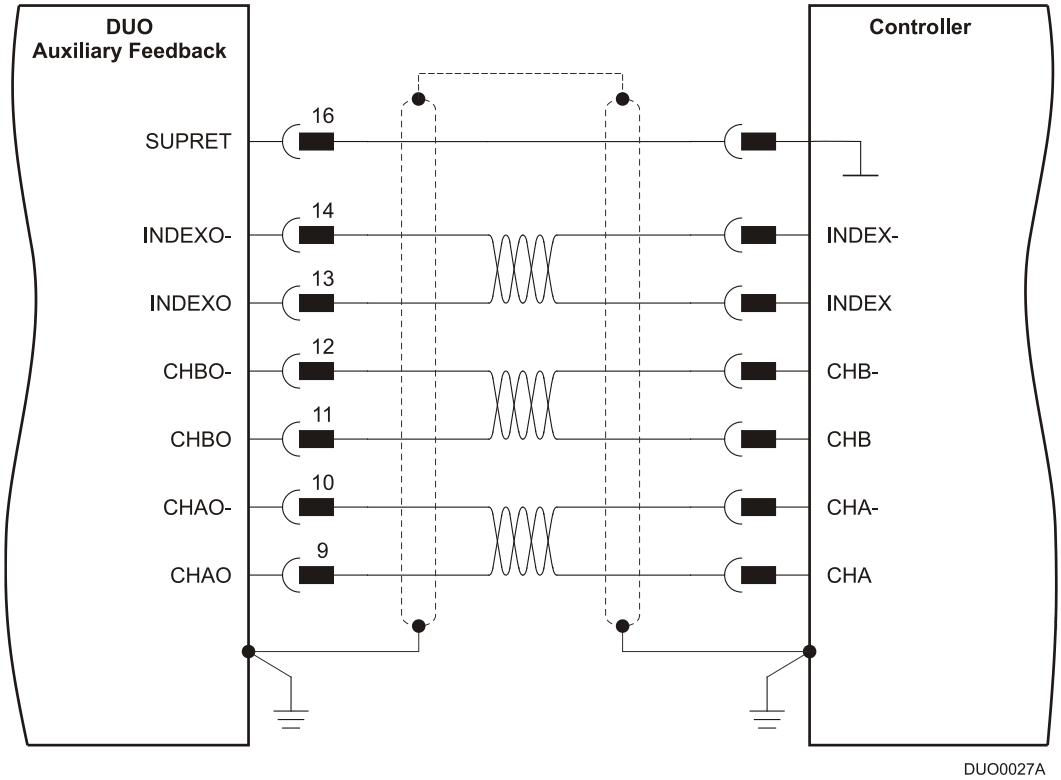


Figure 16: Emulated Encoder Outputs of the Resolver or Analog Encoder - Connection Diagram

3.10.3. Auxiliary Feedback - Differential Encoder Input Option (YA[4]=2)

The Whistle can be used as a slave by receiving the position data (on Port B1) of the master encoder in Follower or ECAM mode. In this mode Port B2 provides **differential buffered Auxiliary outputs of B1** for the next slave axis in Follower or ECAM mode.

Below are the signals on the Auxiliary Feedback ports when the Whistle Auxiliary Feedback port is set up to run as a differential Auxiliary input:

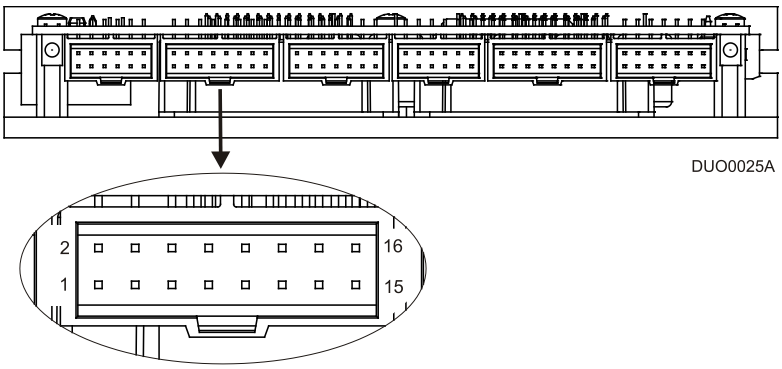
Port	Pin	Signal	Function
PWR	1	+5V	Encoder supply voltage
PWR	2	COMRET	Common return
B1	3	CHA	Auxiliary channel A *input*
B1	4	CHA-	Auxiliary channel A complement *input*
B1	5	CHB	Auxiliary channel B *input*
B1	6	CHB-	Auxiliary channel B complement *input*
B1	7	INDEX	Auxiliary Index Input
B1	8	INDEX-	Auxiliary Index complement Input
B2	9	CHAO	Buffered Channel A output
B2	10	CHAO-	Buffered Channel A complement output
B2	11	CHBO	Buffered channel B output
B2	12	CHBO-	Buffered channel B complement output
B2	13	INDEXO	Buffered Index output
B2	14	INDEXO-	Buffered Index complement output
PWR	15	+5V	Encoder supply voltage
PWR	16	COMRET	Common return
Pin Positions			
			

Table 9: Differential Auxiliary Encoder Input Option along with Differential Encoder Outputs on Auxiliary Feedback - Pin Assignments

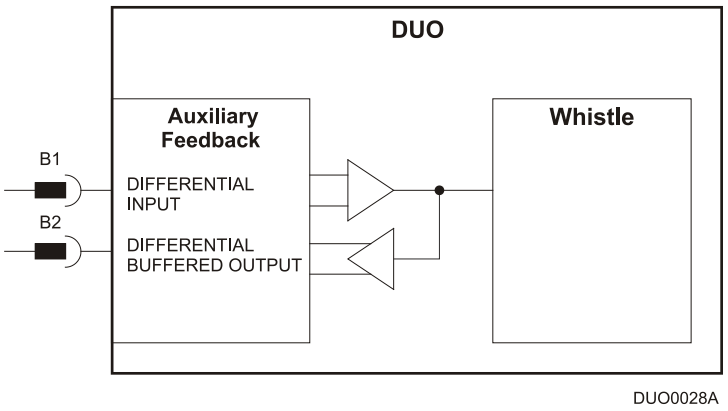


Figure 17: Differential Auxiliary Input Option - Block Diagram

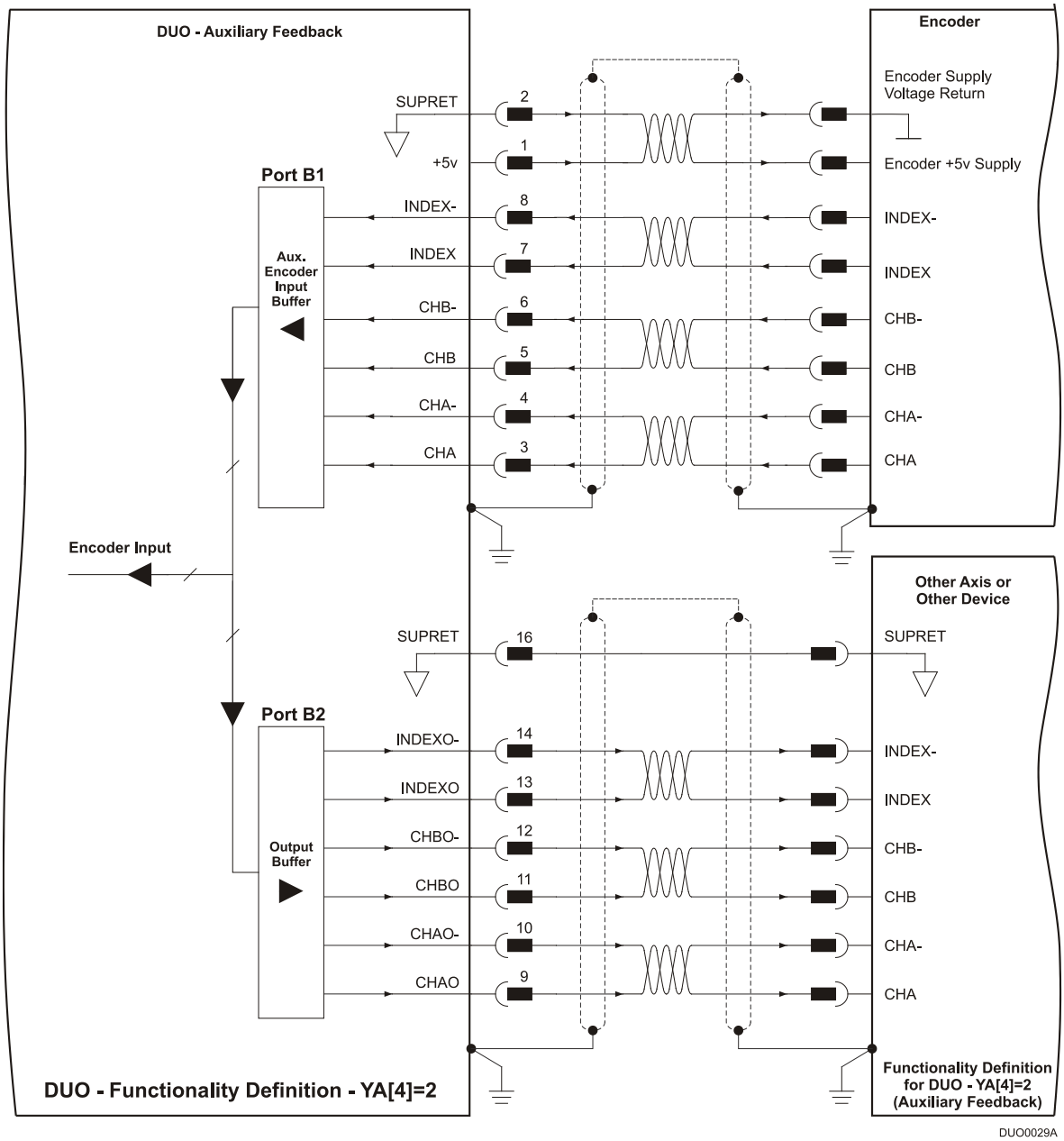


Figure 18: Differential Auxiliary Input Option on Auxiliary Feedback - Connection Diagram

3.10.4. Auxiliary Feedback – Differential Pulse-and-Direction Input Option (YA[4]=0)

This mode is used for input of differential pulse-and-direction position commands on Port B1. In this mode Port B2 provides **differential buffered pulse-and-direction outputs of B1** for another axis.

Below are the signals on the Auxiliary Feedback ports when set up to run as a differential pulse-and-direction input:

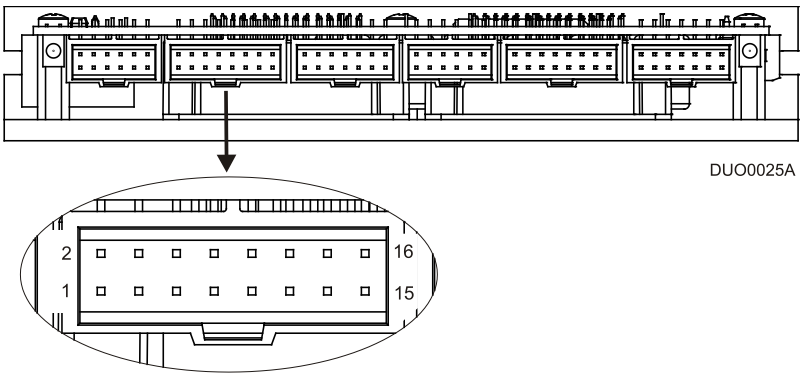
Port	Pin	Signal	Function
PWR	1	+5V	Encoder supply voltage
PWR	2	COMRET	Common return
B1	3	CHA	Auxiliary Pulse *input*
B1	4	CHA-	Auxiliary Pulse complement *input*
B1	5	CHB	Auxiliary Direction *input*
B1	6	CHB-	Auxiliary Direction complement *input*
B1	7	NA	Do not connect this pin
B1	8	NA	Do not connect this pin
B2	9	CHAO	Buffered Pulse output
B2	10	CHAO-	Buffered Pulse complement output
B2	11	CHBO	Buffered Direction output
B2	12	CHBO-	Buffered Direction complement output
B2	13	NA	Do not connect this pin
B2	14	NA	Do not connect this pin
PWR	15	+5V	Encoder supply voltage
PWR	16	COMRET	Common return
Pin Positions			
			

Table 10: Pulse-and-Direction Pin Assignment on Auxiliary Feedback

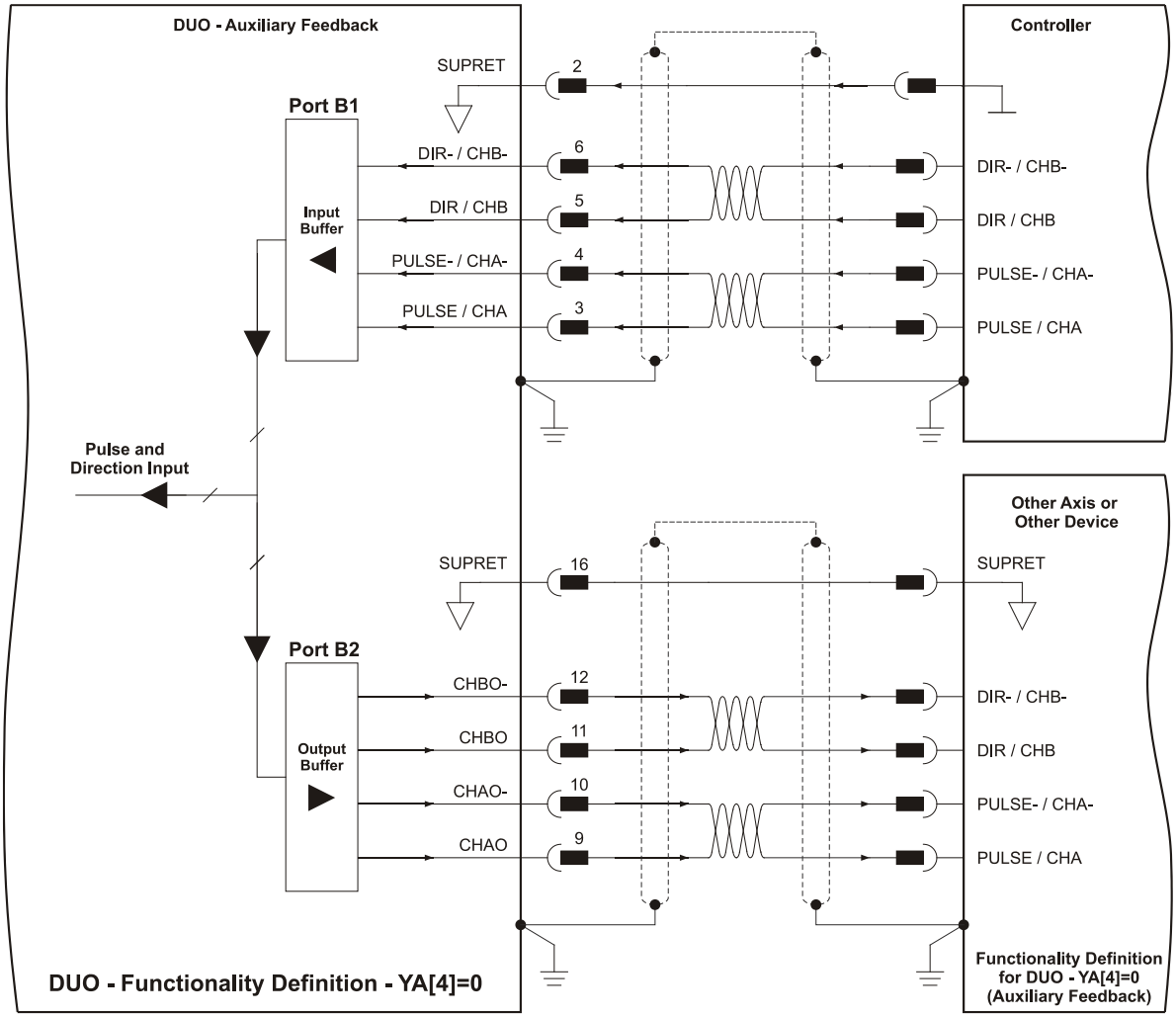


Figure 19: Pulse-and-Direction Input Option on Auxiliary Feedback - Connection Diagram

3.11. I/O

Each Whistle on the Duo has 6 digital inputs, 2 digital outputs and a single analog input.

The I/O port has a 14-pin Molex Header plug with the following pin-outs.

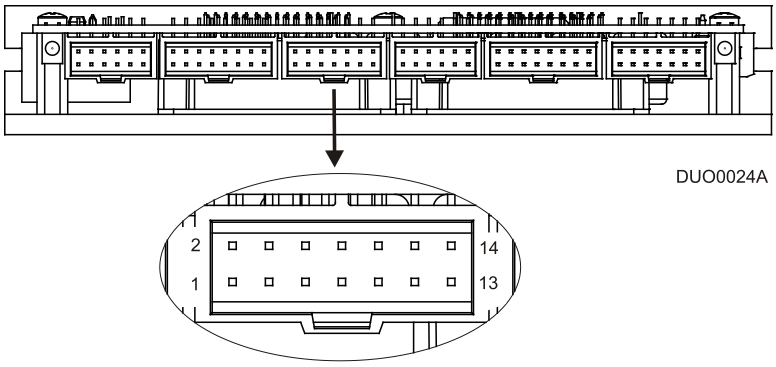
Pin	Signal	Function
1	OUT1	Programmable Digital output 1
2	OUTRET1	Programmable Digital output 1 return
3	OUT2	Programmable Digital output 2
4	OUTRET2	Programmable Digital output 2 return
5	IN1	Programmable Digital input 1
6	IN2	Programmable Digital input 2
7	IN3	Programmable Digital input 3
8	IN4	Programmable Digital input 4
9	IN5	Programmable Digital input 5
10	IN6	Programmable Digital input 6
11	INRET	Programmable Digital input return
12	COMRET	Common return
13	ANALIN1+	Analog input 1+
14	ANALIN1-	Analog input 1-
Pin Positions		
		

Table 11: I/O Port and Cable - Pin Assignment for Each Axis

3.11.1. Digital Input

The Default Digital Input level Signal is set to 24v (PLC).

Note: 5 V is also available (TTL).

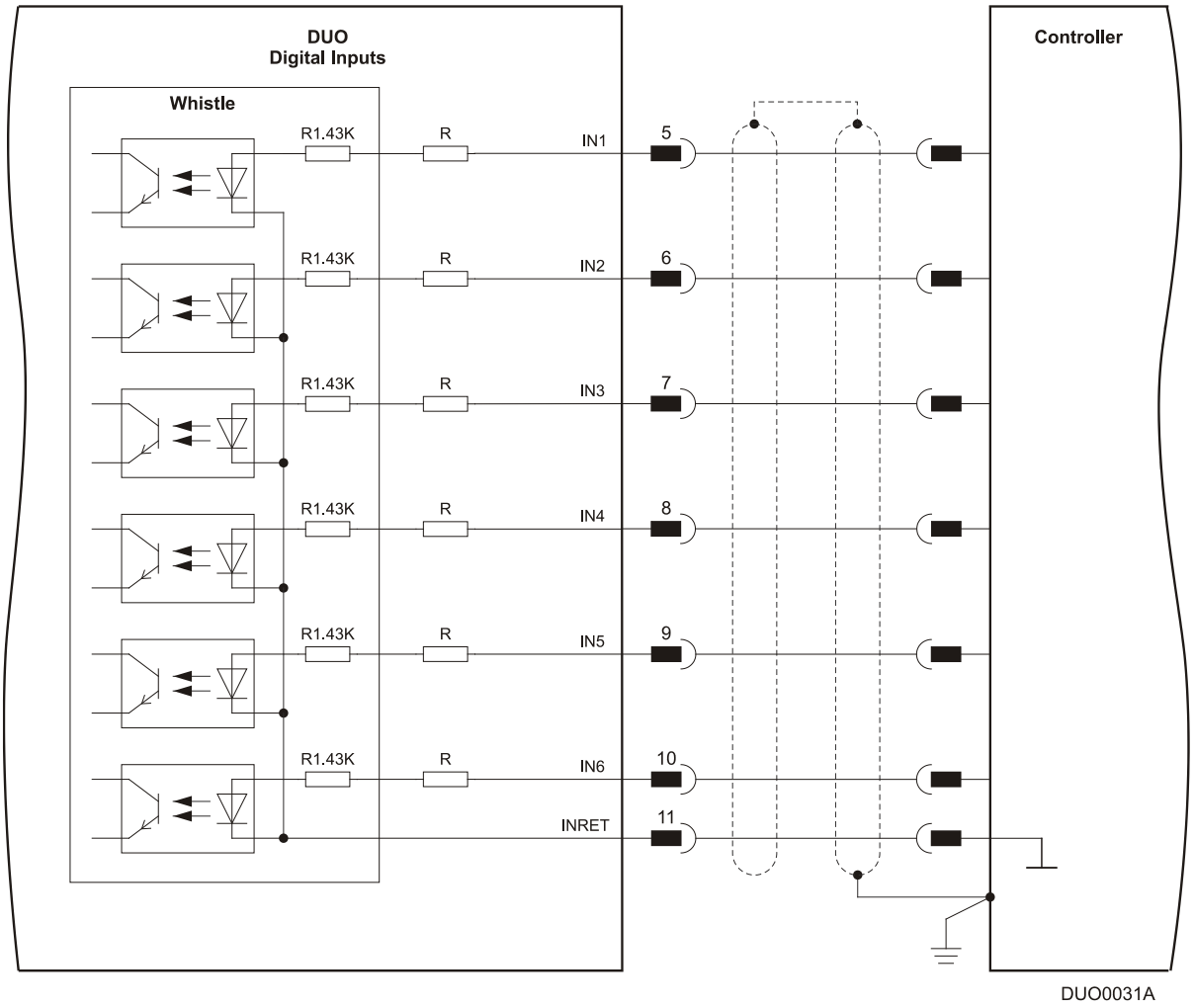


Figure 20: Digital Input Connection Diagram

3.11.2. Digital Output

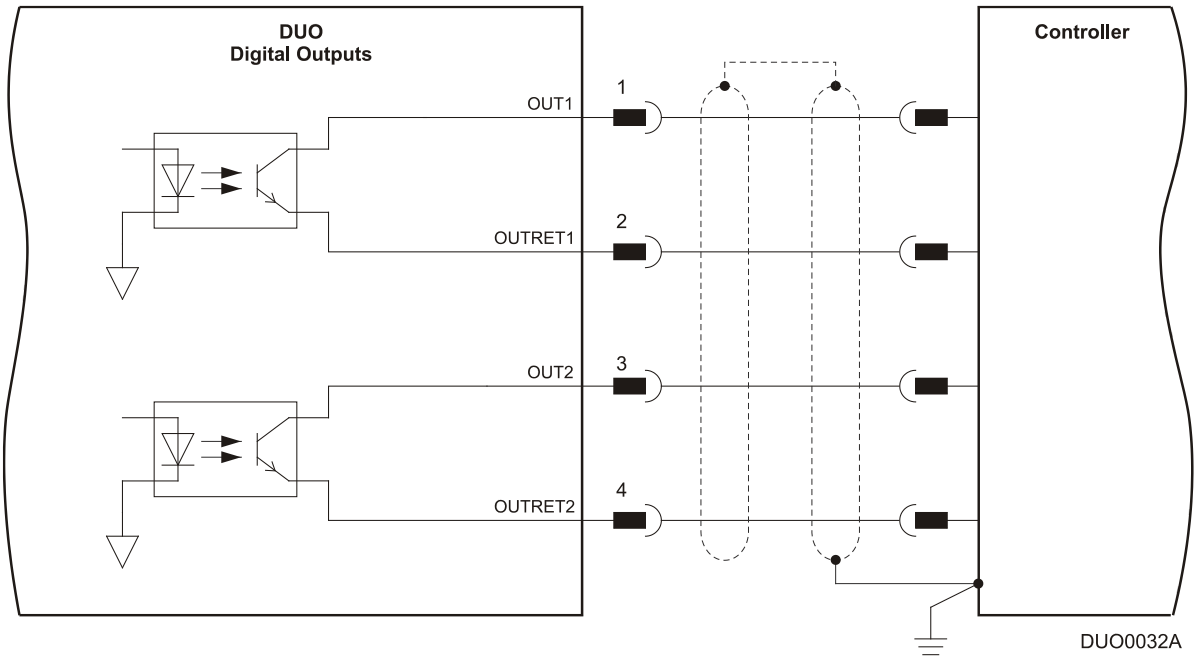


Figure 21: Digital Output Connection Diagram

3.11.3. Analog Input

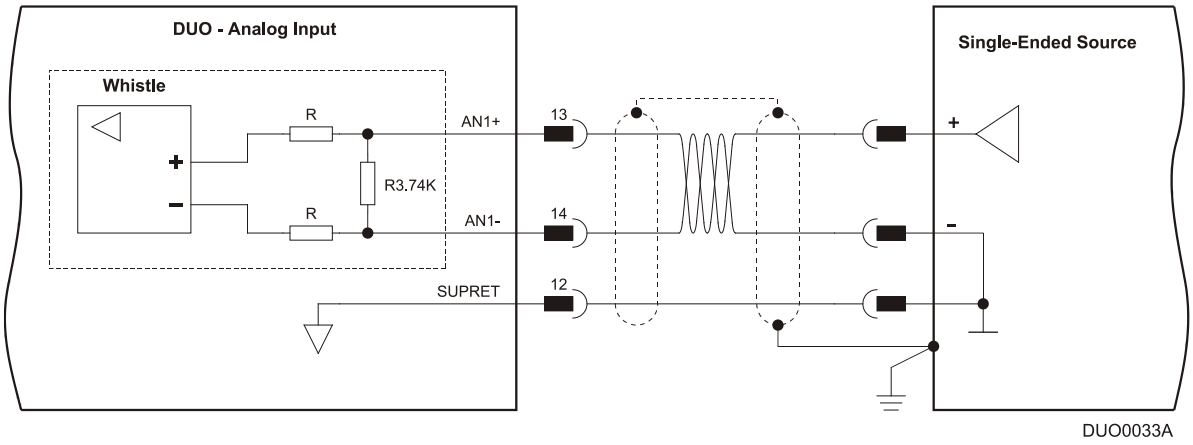


Figure 22: Analog Input with Single-Ended Source

3.12. Communications

The communication cables use an 8-pin RJ-45 plug that connect to the RS232 and CAN ports on the Duo.

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

a. RS232, full duplex

b. CAN

RS232 communication requires a standard, commercial 3-core null-modem cable connected from the Duo 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.

For ease of setup and diagnostics of CAN communication, RS232 and CAN can be used simultaneously.

3.12.1. RS-232 Communication

Notes for connecting the RS-232 communication cable:

- 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 RS-232 communication port is **non-isolated**.
- The male RJ plug must have a shield cover.
- Ensure that the shield of the cable is connected to the shield of the RJ plug. The drain wire can be used to facilitate the connection.

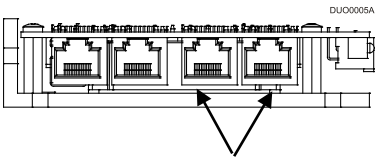
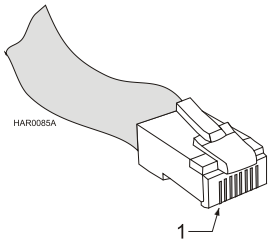
Pin	Signal	Function	Pin Positions
1, 2	—	—	 RS-232 
3	Tx	RS232 transmit	
4	—	—	
5	COMRET	Communication return	
6	Rx	RS232 receive	
7, 8	—	—	
Body	Drain Wire	shield	

Table 12: RS232 Cable - Pin Assignments

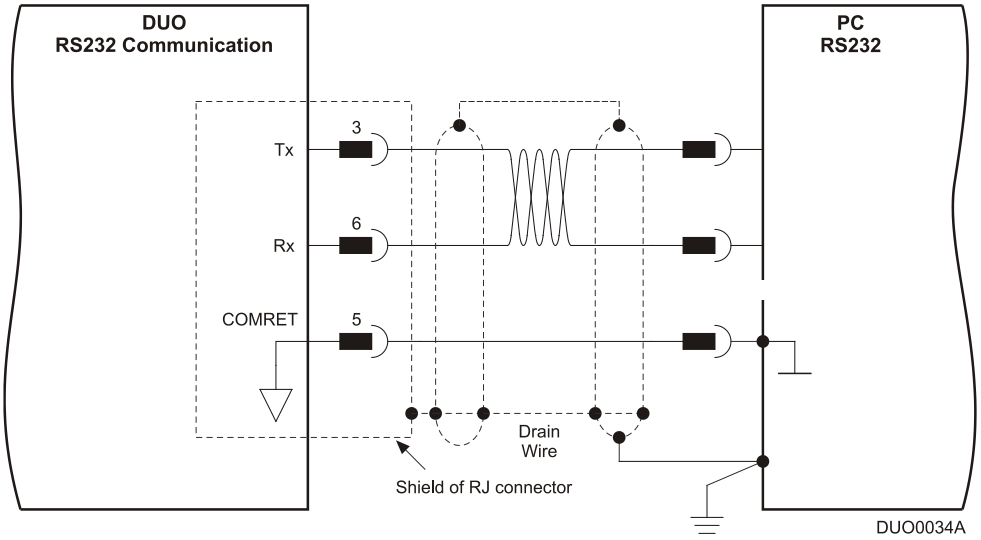


Figure 23: RS232 Connection Diagram

3.12.2. CAN Communication

Notes for connecting the CAN communication cable:

- Use 26 or 28 AWG twisted pair shielded cables. For best results, the shield should have aluminum foil and be covered by copper braid with a drain wire
- 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 CAN communication port is **non-isolated**.
- The male RJ plug must have a shield cover.
- Ensure that the shield of the cable is connected to the shield of the RJ plug.
  The drain wire can be used to facilitate the connection.
- For "daisy-chain" connections, connect a termination 120-Ω resistor at each of the two ends of the network cable.

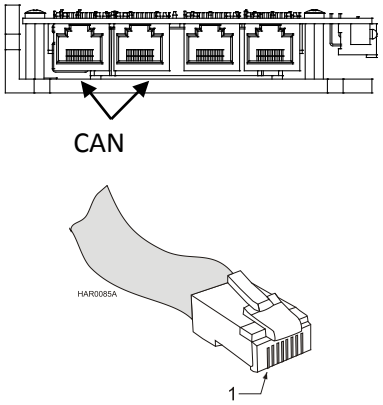
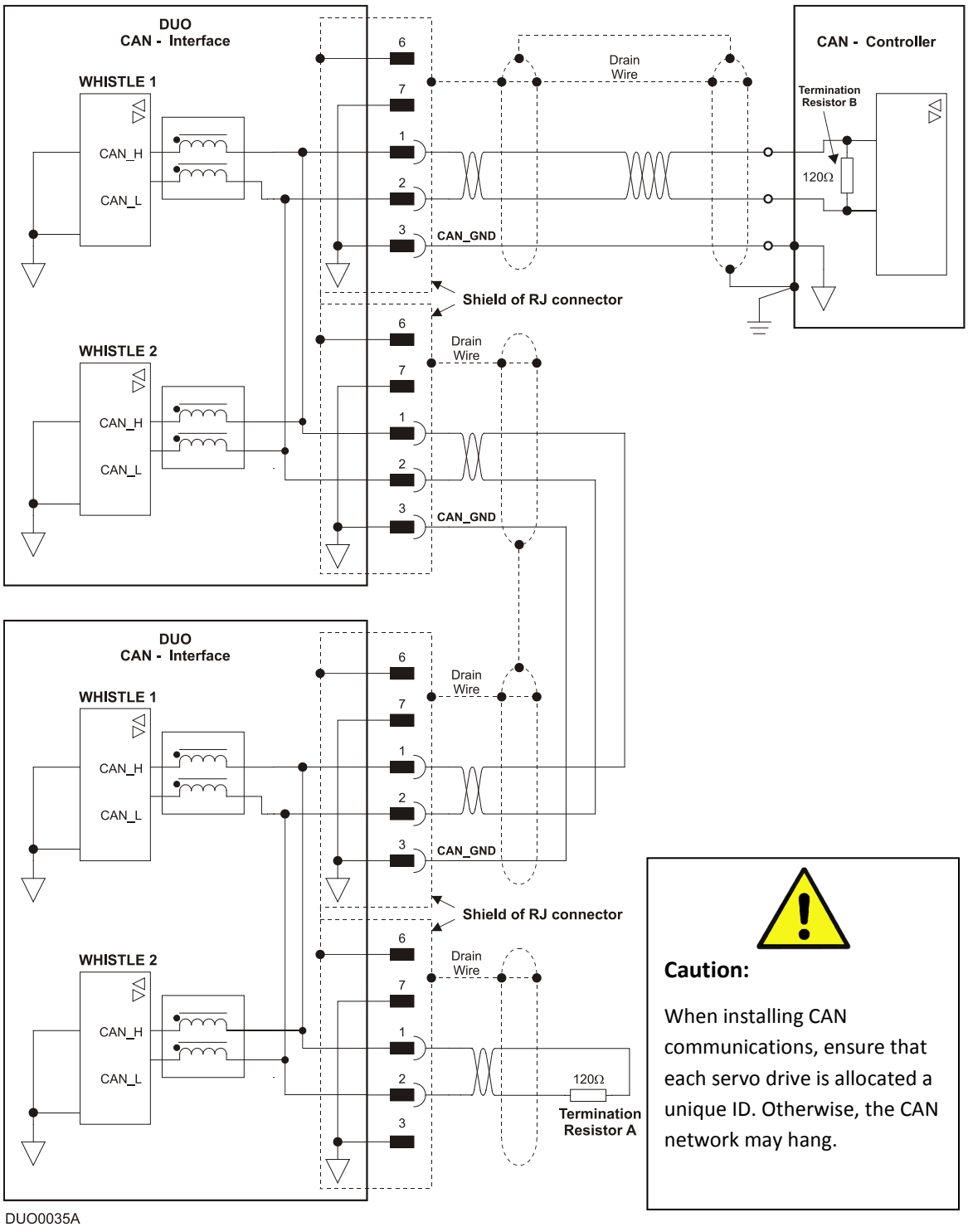
Pin	Signal	Function	Pin Positions
1	CAN_H	CAN_H busline (dominant high)	
2	CAN_L	CAN_L busline (dominant low)	
3	CAN_GND	CAN ground	
4, 5	N/A	—	
6	CAN_SHLD	Shield, connected to the RJ plug cover	
7	CAN_GND	CAN Ground	
8	N/A	—	
body	Drain Wire	shield	

Table 13: CAN Cable - Pin Assignments



Caution:

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

Figure 24: CAN Network Connection Diagram

3.13. Powering Up

After the cables have been connected to their devices, the Duo is ready to be powered up.

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

3.14. Initializing the System

After the Duo 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 Duo. 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 Duo's features determine how it controls motion, as well as how it processes host commands, feedback and other input.

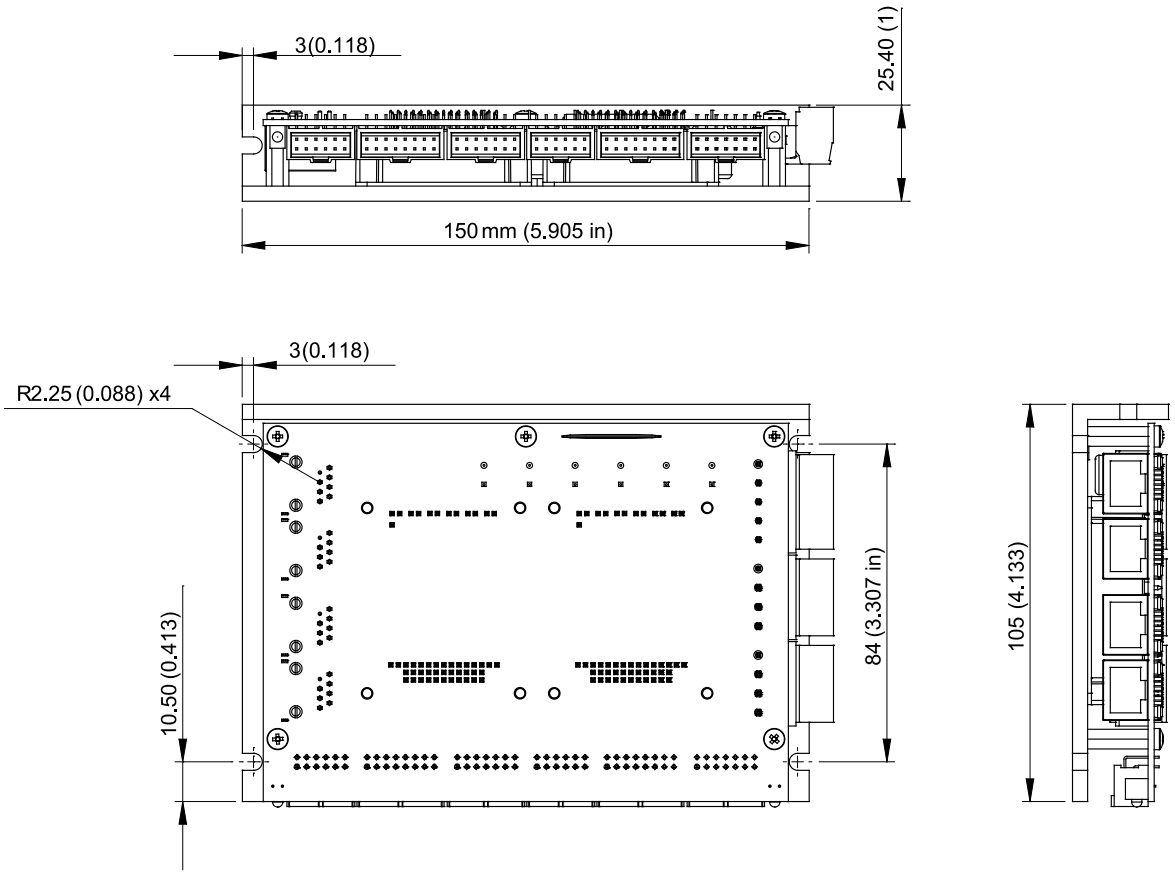
- Operating power
  - DC power supply: 12 to 95 VDC source
- DC BUS
  - DC power supply
- Control supply
  - A separate DC power supply 12 to 95 VDC serves as both the auxiliary supply *and* the backup supply (Option)
- Operating modes
  - Current, velocity and position
- Commutation alternatives
  - Sinusoidal vector control
  - Trapezoidal
  - DC brush
- Feedback alternatives
  - Incremental encoder + digital Halls
  - Incremental encoder only
  - Digital Halls
  - Resolver
  - Sin / Cos
  - Sin / Cos + Digital Halls
  - Analog Halls
  - Tachometer
  - Potentiometer
- Communication
  - Simultaneous operation of RS-232 and CAN DS 402 User programming
- User Programming
  - Third-generation programming environment (language and Elmo Studio)

- Encoder Inputs
  - Two
- Event capturing inputs
- Event triggered programming structure
- Analog inputs
  - 1 differential inputs with 12-bit resolution
- Enable input, limit switches and emergency stop handling
- Smart multi-purpose inputs
  - Programmable as Enable, Forward and Reverse Limit Switches, Home, Capture
- Uncommitted programmable inputs
  - 6 Inputs sharing one single common
- Uncommitted, programmable outputs
  - 2 separated outputs
- Storage memory
  - Large, non-volatile storage of controller parameters and user programs
- Setup, startup and tuning software
  - Windows-based Composer
- Automatic analysis of kinematics
- Status indication
  - Bi-color LED
- Automatic procedures
  - Commutation alignment
  - Phase sequencing
  - Current loop offset adjustment
  - Current loop gain tuning
  - Current gain scheduling
  - Velocity loop offset adjustment
  - Velocity gain tuning
  - Velocity gain scheduling
  - Position gain tuning
- Motion modes
  - Point-to-point (PTP)
  - Jogging
  - Position-Velocity-Time (PVT)
  - Position-Time (PT)
  - Pulse-and-direction

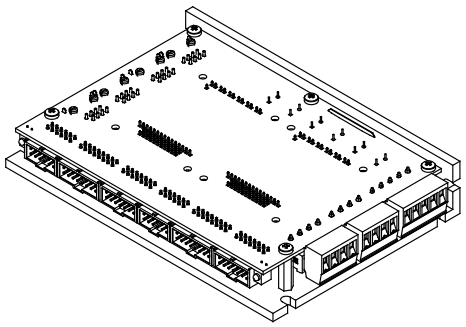
4.2. Built-In Protection

- Software error handling
  - Software-based
- Status reporting
  - Available for a large number of fault conditions
- Protection against:
  - Short circuit between motor power outputs
  - Short circuit between each motor power output and DC bus return
  - Failure of internal power supply
  - Heatsink over-temperature
  - Under/over voltage
  - Loss of commutation signals
  - Loss of velocity feedback
  - “Bad” commutation
  - Communication error

4.3. Duo Dimensions



DUO0037A



4.4. Power Ratings

Feature	Units	1/60	2.5/60	5/60	10/60	15/60	1/100	2.5/100	5/100	10/100	15/100
Minimum supply voltage	VDC	8.5					12				
Nominal supply voltage	VDC	48					85				
Maximum supply voltage	VDC	59					95				
Max. output power from the drive without heatsink	W	50	120	240	480	720	75	180	400	800	1200
Efficiency at rate power	%	> 99									
Output Voltage	%	> 95% of supply VDC at f=22 KHz									
DC and Trapezoidal Commutation Continuous Current Limit (Ic)	A	1	2.5	5	10	15	1	2.5	5	10	15
Sinusoidal Commutation Continuous RMS Current Limit (Ic)	A	0.7	1.8	3.6	7	10.7	0.7	1.8	3.6	7	10.7
Peak current limit (RMS)	A	2 x Ic									
Pulse-Width Modulation (PWM) Switching Frequency	KHz	22 +/-5% default on the motor									
Switching Method		Advanced Unipolar PWM									

Note on current ratings: The current ratings of the Duo are given in units of DC amperes (ratings that are used for trapezoidal commutation or DC motors). The RMS (sinusoidal commutation) value is the DC value divided by 1.41.

4.5. Control Specifications

4.5.1. Current Loop

Feature	Details
Controller type	Vector, digital
Current sampling time	70 to 100 µsec
Current loop bandwidth	1400 to 2500 Hz
Compensation for bus voltage variations	Gain scheduling
Motor types	• AC brushless (sinusoidal) • DC brushless (trapezoidal) • DC brush • Linear brushless motor
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 step response (including settling time)	300 to 400 µsec
Current rise time	150 to 200 µsec

4.5.2. Velocity Loop

Feature	Details
Controller type	PI
Speed sampling time	140 to 200 µsec (x2 current loop sample time)
Velocity loop bandwidth	
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 • Incremental encoder only • Digital Halls • Resolver • Sin / Cos • Sin / Cos+ Digital Halls • Analog Halls • Tachometer • Potentiometer **Note:** With all feedback options, 1/T with automatic mode switching is activated (gap, frequency and derivative).
Velocity command options	• Analog • Internally calculated by either jogging or step **Note:** All software-calculated profiles support on-the-fly changes.

4.5.3. Position Loop

Feature	Details
Controller type	124 PIP
Position sampling time	280 to 400 µsec (x 4 current loop sample time)
Analog input command resolution	12-bit inputs
PWM resolution	12-bit
PWM switching frequency on the load	2/ Ts (factory default 22 kHz on the motor)
Control inputs	PLC or +5V level

4.6. Feedbacks

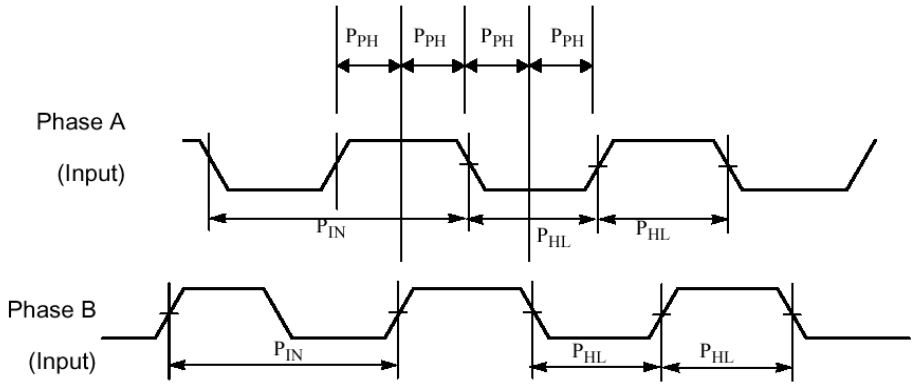
The Duo can receive and process feedback input from diverse types of devices.

4.6.1. 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 single, 20 MHz quadrature
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 ns
Maximum encoder input voltage range	Common mode: ±7 V Differential mode: ±7 V

4.6.2. Feedback Supply Voltage

Feature	Details
Encoder/Hall supply voltage	5 V +5%
Maximum encoder supply current	200 mA (For the main encoder only)



4.6.3. Digital Halls

Feature	Details
Halls inputs	• HA, HB, HC. • 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 also support open collector Halls)
Maximum frequency	f_{MAX} : 2 kHz

4.6.4. 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	Signal amplitudes mismatch Signal phase shift Signal offsets

4.6.5. 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	0.5
Reference frequency	1/Ts (Ts = sample time in seconds)
Reference voltage	Supplied by the Duo
Reference current	Up to ±50 mA

4.6.6. 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.

4.6.7. Potentiometer

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

4.6.8. Auxiliary Feedback Port (output mode YA[4]= 4)

Feature	Details
Emulated output	• A, B, Index • Differential
Output current capability	Maximum output current: I_{OH} (max) = 2 mA High level output voltage: V_{OH} > 3.0 V Minimum output current: I_{OL} = 2 mA Low level output voltage:V_{OL} < 0.4 V
Available as options	• Emulated encoder outputs of analog encoder • Emulated encoder outputs of resolver
Maximum frequency	f_{MAX} : 5 MHz pulses/output
Edge separation between A & B	Programmable number of clocks to allow adequate noise filtering at remote receiver of emulated encoder signals
Index (marker):	Length of pulse is one quadrature (one quarter of an encoder cycle) and synchronized to A&B

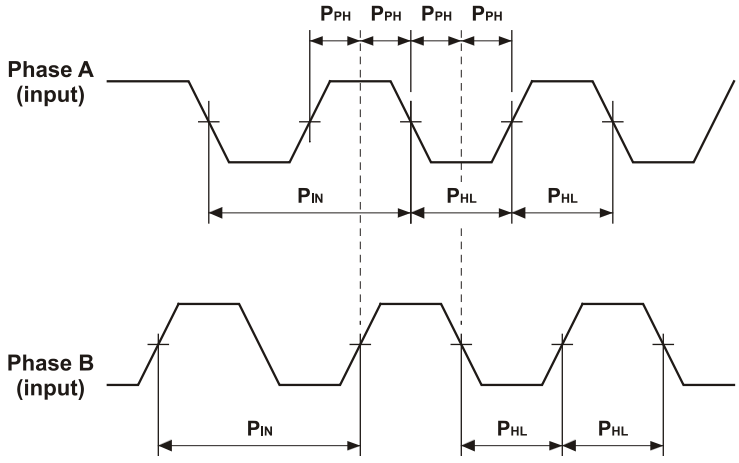


Figure 25: Auxiliary Feedback - Encoder Phase Diagram

4.6.9. Auxiliary Feedback Port (input mode YA[4]= 2, 0)

Feature	Details
Encoder input, pulse and direction input	• A, B, Index • Differential
Output current capability	V_{In} Low: 0 V < V_{IL} < 0.8 V V_{In} High: 2 V < V_{IH} < 5 V Maximum absolute voltage: 0 < V_{In} < 5.5 V Input current: ±1 µA
Encoder/Hall supply voltage	5 V +5%
Maximum encoder supply current	200 mA
Available as options	• Differential Encoder inputs • Differential Pulse and Direction inputs
Edge separation between A & B	Programmable number of clocks to allow adequate noise filtering at remote receiver of emulated encoder signals
Index (marker):	Length of pulse is one quadrature (one quarter of an encoder cycle) and synchronized to A&B

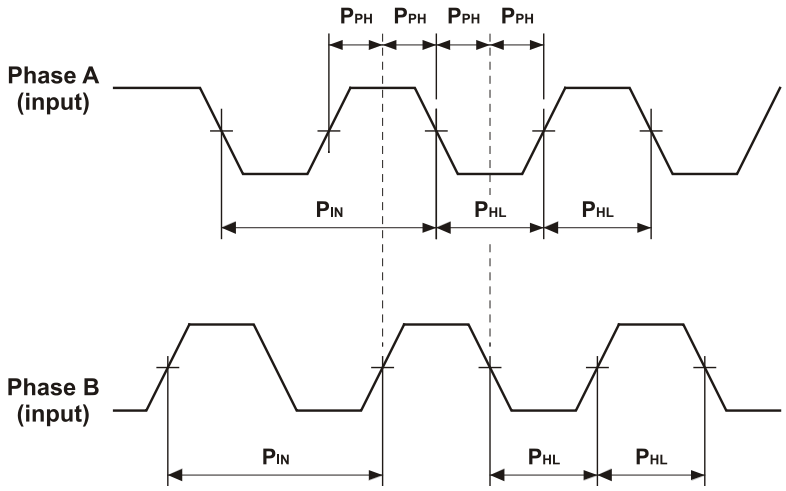


Figure 26: Auxiliary Feedback - Encoder Phase Diagram

4.7. I/Os

4.7.1. Digital Input Interface – 6 Digital Inputs

Feature	Details
Type of input	• Optically isolated • All six inputs share one signal return line
Input current for all inputs	Iin = 6.5 mA @ Vin = 24 V
Input voltage level	24 V **Note:** 5 V level is also available.
Minimum pulse width	> 4 x TS, where TS is sampling time
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<4xTS If input is set to General input, execution depends on program. Typical execution time: ≅ 0.5 msec.
High-speed inputs – 5 & 6 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.

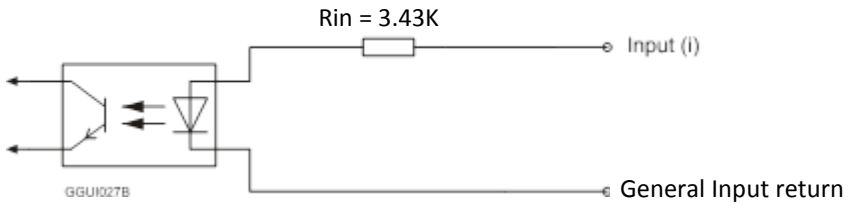
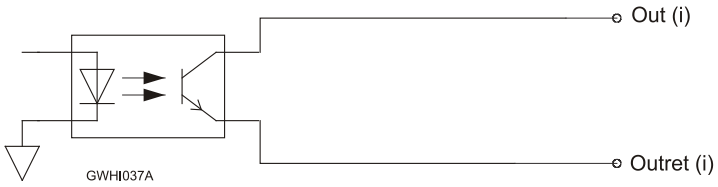


Figure 27: Digital Input Schematic

4.7.2. Digital Output Interface – 2 Digital Outputs

Feature	Details
Type of output	• Optically isolated • Open collector and open emitter
Maximum supply output (VCC)	30 V
Max. output current I_{out} (max) (V_{out} = Low)	I_{out} (max) ≤ 10 mA
VOL at maximum output voltage (low level)	V_{out} (on) ≤ 0.3 V
R_L	The external resistor R_L must be selected to limit the output current to no more than 10 mA. $R_L = \frac{VCC - VOL}{I_{out}(max)}$
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 28: Digital Output Schematic**	

4.7.3. Analog Inputs – 1 Analog Input

Feature	Details
Analog input - maximum differential mode voltage	+20 V
Analog input - maximum common mode voltage	+10 V
Input resistance	3.74 KΩ

4.8. Mechanical Specifications

Feature	Details
Mounting	The Duo designed for two standard mounting options: • Wall Mount, along the back (can also be mounted horizontally on a metal surface) • Book Shelf, along the side
Overall dimensions	150 X 105 X 25.4 (5.9 X 4.13 X 1 in)
Weight	~ 450 grams

4.9. 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

4.10. 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)

Chapter 5: Cables (Optional)

5.1. Cable Photos

Main Feedback: CBL- HDRFB-001

Auxiliary Feedback: CBL- HDRAUX-001

I/O: CBL- HDRIO-001

RS-232 Com.: CBL-RJ452321

CAN Com.: CBL-RJ45CAN1

5.2. Cable Kit

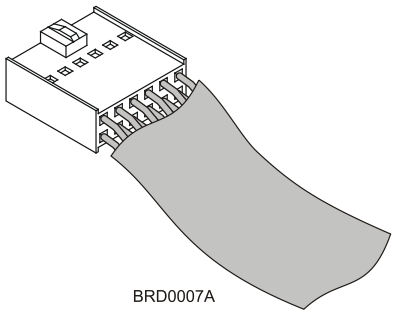
The cables are all 2 m in length. Each set contains the cables listed below. Additional cable kit and/or individual cables (in multiples of 10 each) are available from Elmo.

Cable Application	Cable Part. No.	QTY
Main Feedback	CBL-HDRFB-001	2
Auxiliary Feedback	CBL-HDRAUX-001	2
I/O	CBL-HDRIO-001	2
RS-232 Communications	CBL-RJ452321	1
CAN Communications	CBL-RJ45CAN1	1

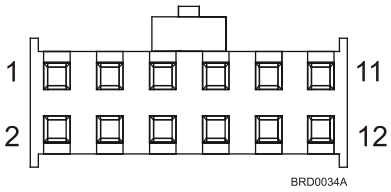
5.3. Main Feedback Cable (CBL-HDRFB-001)

The Main Feedback cable (CBL-HDRFB-001) is made of a 24-AWG shielded cable with a 12-pin Molex Header socket. It connects to the Main Feedback port on the Duo. It is open on its other side so that it can be connected to customer-specific motor connector.

Pin	Color	Signal	Pairs
1	Brown	+5V	pair
2	White	COMRET	
3	Cyan	CHA	pair
4	Orange	CHA-	
5	Purple	CHB	pair
6	Black	CHB-	
7	Red	INDEX	pair
8	Blue	INDEX-	
9	Green	HA	pair
10	Yellow	HB	
11	Pink	HC	pair
12	Drain wire	COMRET	



12-Pin Molex Header Socket



Front View

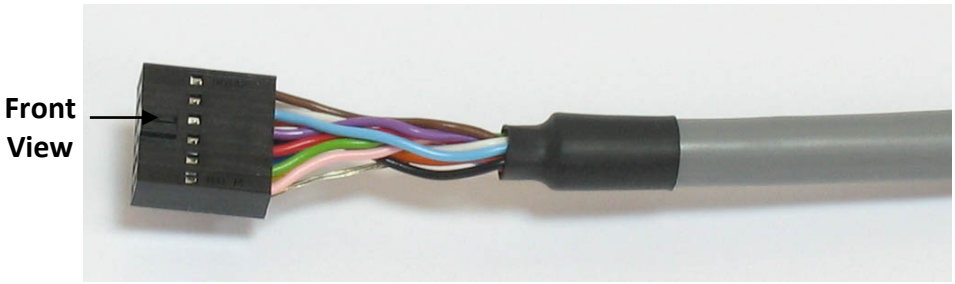
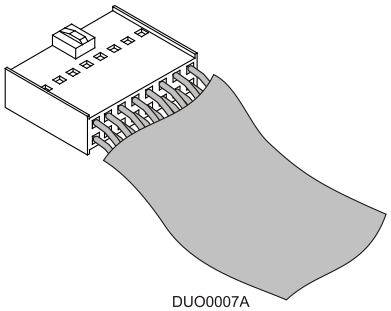


Figure 29: Single-Sided Main Feedback Cable (Part No. CBL-HDRFB-001)

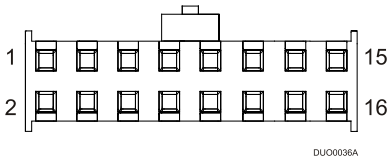
5.4. Auxiliary Feedback (CBL-HDRAUX-001)

The Auxiliary Feedback cable (CBL-HDRAUX-001) is made of a 24-AWG shielded cable with a 16-pin Molex Header socket. It connects to the Auxiliary Feedback port on the Duo.

Pin	Color	Signal	Pairs
1	Brown	+5V	pair
2	White	COMRET	
3	Cyan	CHA	pair
4	Orange	CHA-	
5	Purple	CHB	pair
6	Black	CHB-	
7	Red	INDEX	pair
8	Blue	INDEX-	
9	Pink	CHAO	pair
10	Grey	CHAO-	
11	Yellow	CHBO	pair
12	Green	CHBO-	
13	White-Red	INDEXO	pair
14	White-Black	INDEXO-	
15	White-Green	+5V	pair
16	White- Yellow	COMRET	



16-Pin Molex Header Socket



Front View

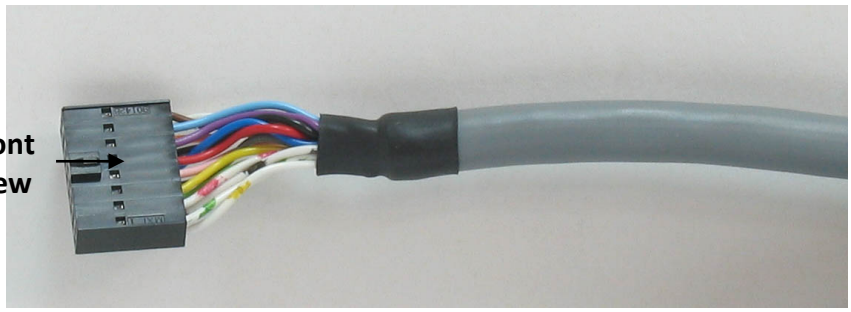
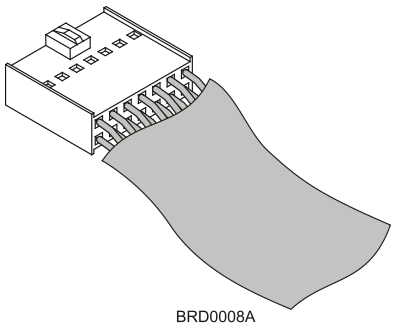


Figure 30: Single-Sided Auxiliary Feedback Cable (Part No. CBL-HDRAUX-001)

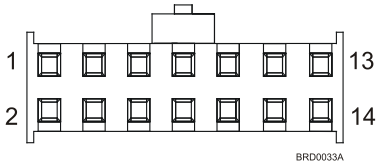
5.5. I/O (CBL-HDRIO-001)

The I/O cable (CBL-HDRIO-001) is made of a 24-AWG shielded cable with a 14-pin Molex Header socket. It connects to the I/O port on the Duo.

Pin	Color	Signal	Pairs
1	Orange	OUT1	pair
2	Cyan	OUTRET1	
3	Black	OUT2	pair
4	Purple	OUTRET2	
5	Brown	IN1	pair
6	White	IN2	
7	Green	IN3	pair
8	Yellow	IN4	
9	Gray	IN5	pair
10	Pink	IN6	
11	Blue	INRET	pair
12	Red	COMRET	
13	White-Black	ANALIN1+	pair
14	White-Red	ANALIN1-	



14-Pin Molex Header Socket



Front View

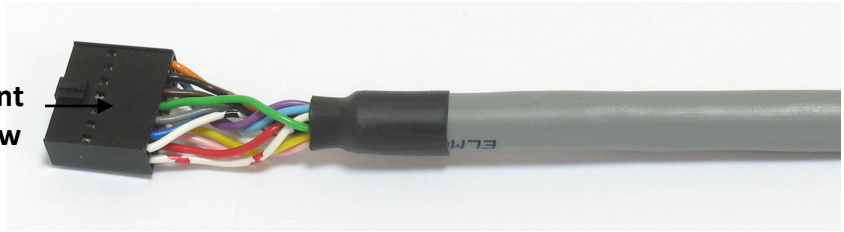


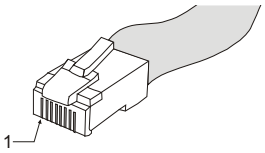
Figure 31: Single-Sided I/O Cable (Part No. CBL-HDRIO-001)

5.6. Communication Cables

The communication cables use 26-AWG twisted pair shielded cable. They are connected using an 8-pin RJ-45 plug. Elmo drives can communicate using the following options:

- RS-232 full duplex
- CAN

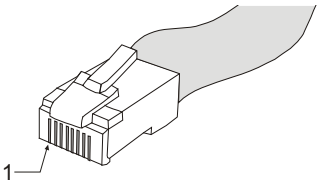
5.6.1. RS-232 Option (CBL-RJ452321)

RJ-45 Pin No.	Color	D-type Female Pin No.	Signal	Description	
1	—	—	—	—	
2	—	—	—	—	
3	Brown	2	Tx	RS232 Transmit	
4	—	—	—	—	
5	White	5	COMRET	Communication Return	
6	Green	3	Rx	RS232 Receive	
7	—	—	—	—	
8	—	—	—	—	
body	Drain Wire	body	shield	cable shield	

Note: The shields of the RJ-45 and D-type plugs are connected to each other through the cable braid.

Figure 32: RS-232 Communications Cable (Part No. CBL-RJ452321)

5.6.2. CAN (CBL-RJ45CAN1)

RJ-45 Pin No.	Color	D-type Female Pin No.	Signal	Description	
1	Green	7	CAN-H	CAN_H bus line	
2	Yellow	2	CAN_L	CAN_L bus line	
3	White	3	CAN_GND	CAN ground	
4	—	—	—	—	
5	—	—	—	—	
7	—	—	—	—	
8	—	—	—	—	
body	Drain Wire	body	shield	cable shield	

Note: The shields of the RJ-45 and D-type plugs are connected to each other through the cable braid.

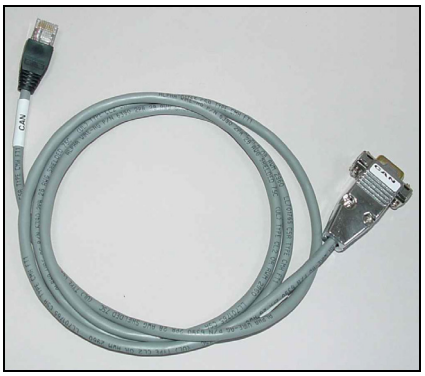


Figure 33: CAN Cable (Part No. CBL-RJ45CAN1)

5.7. Guidelines for Making Your Own Cables

Proper wiring, grounding and shielding are essential for ensuring safe, immune and optimal servo performance of the Duo. If you do not plan to use cables provided by Elmo, follow the instructions below carefully.

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

- Use twisted pair shielded cables for control, feedback and communication connections. For best results, the cable should have an aluminum foil shield covered by a copper braid and should contain a drain wire.

  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.

- 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 or 28 AWG wire for control and feedback cables is satisfactory although 24 AWG is recommended.

- 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.

5.7.1. Recommended Wire Cross Sections

Function	Connection	Details
Motor	PE, M1, M2, M3	14 AWG
Feedback and Control	Main Feedback Auxiliary Feedback I/O	24 AWG twisted pair shielded cables
Communications	RS232 CAN	26 AWG twisted pair shielded cables