SimplIQ Line

Cello
Digital Servo Drive
Installation Guide

October 2017 (Ver. 1.603)

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 Cello servo drive in its installation.
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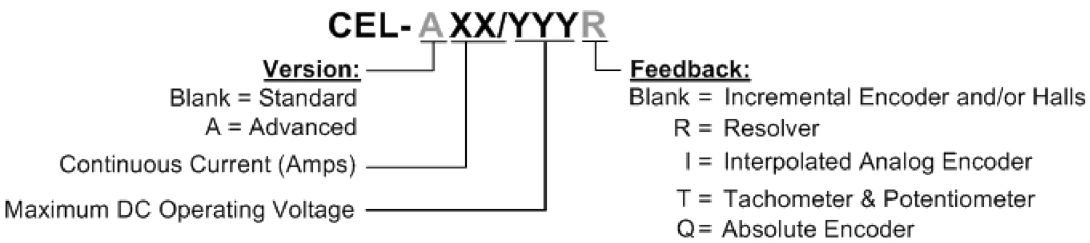
Catalog Number



Cable Kits

Catalog Numbers:

- CBL-CELKIT01 (can be ordered separately)
- CBL-CELKIT02 (can be ordered separately)

For further details, see the documentation for these cable kits (MAN-CBLKIT-CEL.pdf).

Revision History

Version	Date	Details
1.0		Initial release
1.3	Apr 2008	Updated Power Ratings table in □
1.4	Aug 2008	Added Section 1.13.7.4: Differential Pulse-and-Direction Input
1.5	Mar 2010	MTCR 07-009-56: added note to Section 1.13.8.2
1.6	July 2012	Formatted according to new template, updated Catalog Number
1.601	Feb 2013	Added a caution and recommendation on the type of cleaning solution to use for the Elmo unit.
1.602	July 2014	General format update
1.603	Oct 2017	Updated the Warranty Information Section 1.5 and updated the part number label in section 1.11

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Safety Information

In order to achieve the optimum, safe operation of the Cello 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 Cello 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 Cello 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 Cello 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 Cello 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 Cello 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 Cello. High voltages may damage the drive.

The DC power supply voltage range is defined in the table in Section 1.18.

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 Cello, 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 Cello 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 Cello 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 Cello 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 Cello 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 Cello 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.

Introduction

This installation guide describes the Cello 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.

1.6. Drive Description

The Cello 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 Cello features flexible sinusoidal and trapezoidal commutation, with vector control. The Cello can operate as a stand-alone device or as part of a multi-axis network in a distributed configuration.

The Cello 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.

Power to the Cello is provided by a 10 to 195 VDC source. A "smart" control-supply algorithm enables the Cello to operate with the power supply only, *with no need for an auxiliary 24 Volt supply*. If backup functionality is required for storing control parameters in case of power-outs, an external 24 VDC power supply can be connected, providing maximum flexibility and optional backup functionality when needed.

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

1.7. Product Features

1.7.1. 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

1.7.2. 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

1.7.3. 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

1.7.4. 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)

1.7.5. Communication Options

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

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

1.7.6. 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
- Absolute Encoder
- Interpolated Analog (Sine/Cosine) Encoder – up to 250 kHz (analog signal)
  - 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

1.7.7. Fault Protection

The Cello 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

1.8. System Architecture

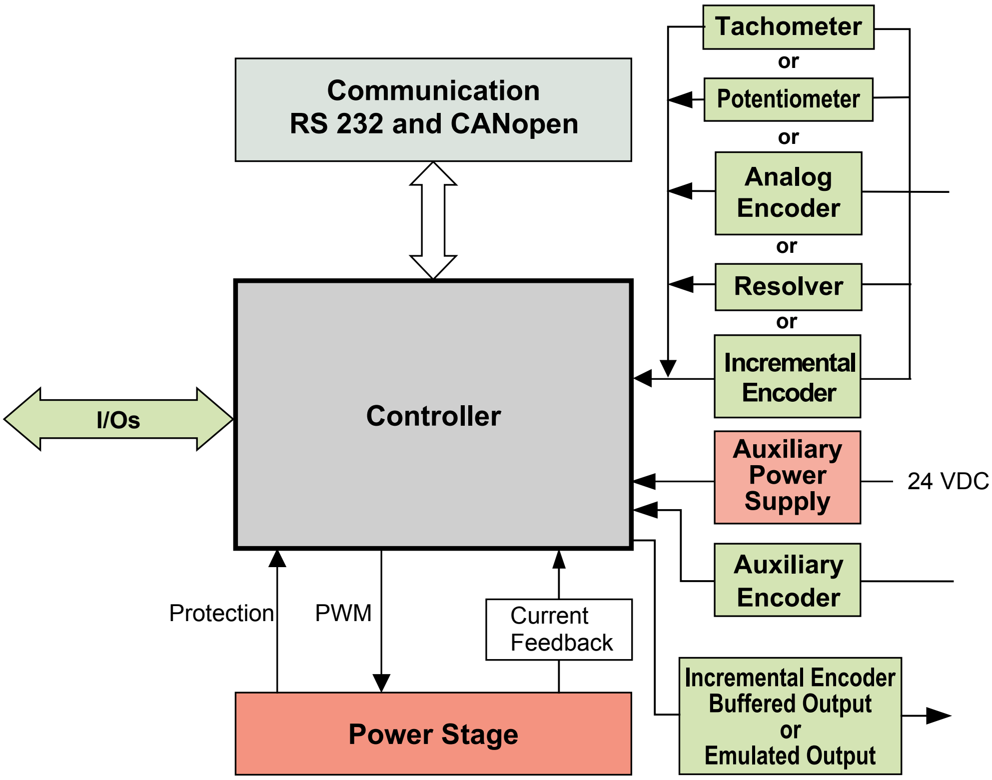


Figure 1: Cello System Block Diagram

1.9. How to Use this Guide

In order to install and operate your Elmo Cello 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 Cello.
- Chapter 4, *Technical Specifications*, lists all the drive ratings and specifications.

Upon completing the instructions in this guide, your Cello 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.

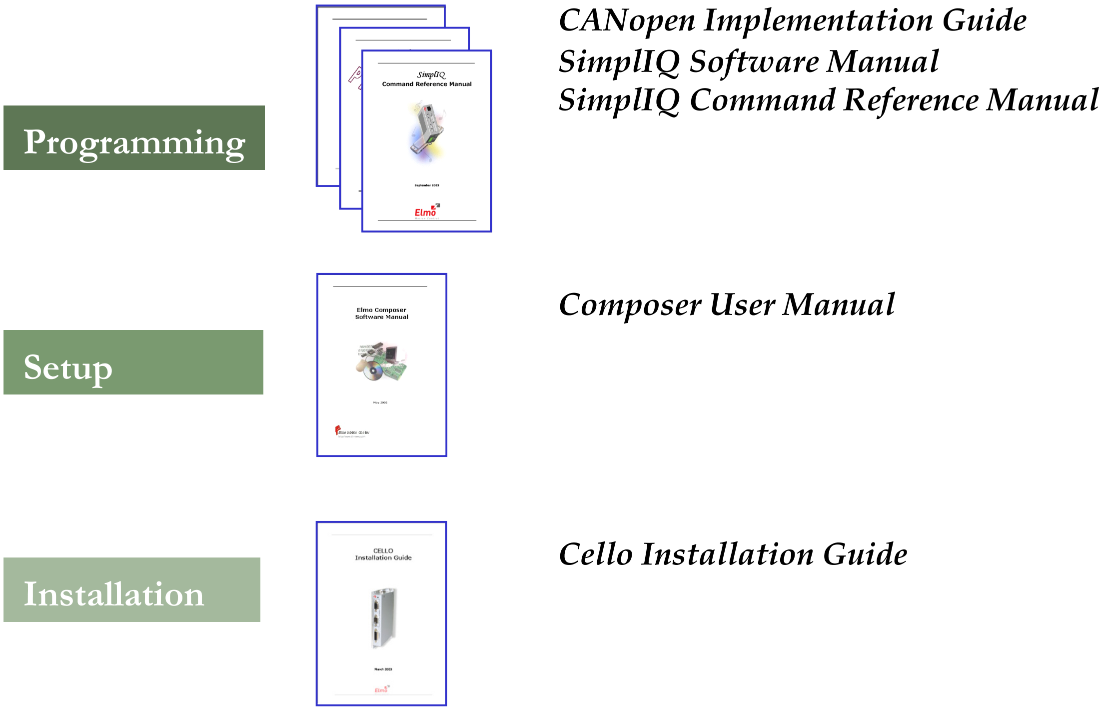


Figure 2: Elmo Documentation Hierarchy

As depicted in the previous figure, this installation guide is an integral part of the Cello 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 Cello motion controller.
- The *SimplIQ Software Manual,* which describes the comprehensive software used with the Cello.

Installation

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

1.10. Before You Begin

1.10.1. Site Requirements

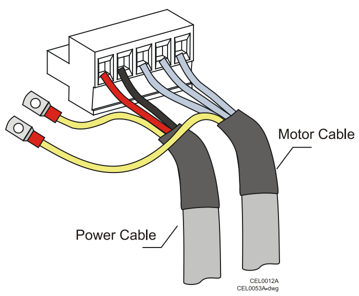
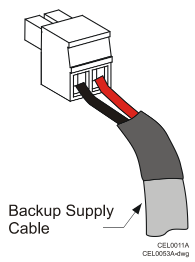
You can guarantee the safe operation of the Cello by ensuring that it is installed in an appropriate environment.

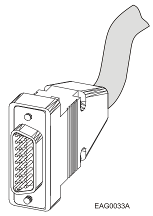
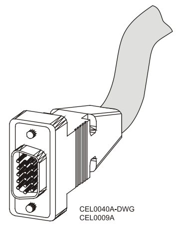
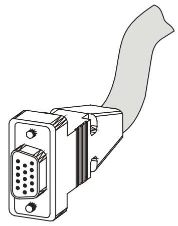
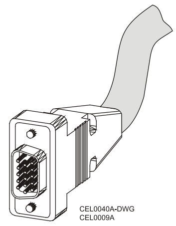
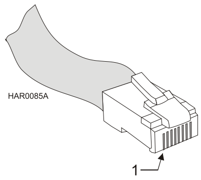
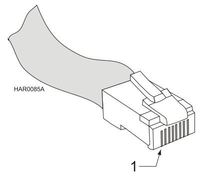
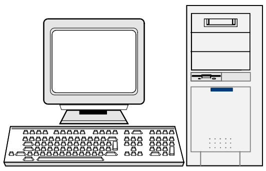
Feature	Value
Ambient operating temperature	0 °C to 40 °C (32 °F to 104 °F)
Maximum operating altitude	2,000 m (6562 feet)
Maximum non-condensing humidity	90%
Operating area atmosphere	No flammable gases or vapors permitted in area
Models for extended environmental conditions are available.	

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

1.10.2. Hardware Requirements

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

Component	Connector	Described in Section	Drawing
Main Power Cable	**VP+ PR**	1.13.2.2	
Motor Cable	**M1 M2 M3**	1.13.2.1	
Backup Supply Cable (if needed)	**24V**	1.13.3	

Component	Connector	Described in Section	Drawing
Main Feedback Cable	**FEEDBACK A**	1.13.5	
Auxiliary Feedback Cable (if needed)	**FEEDBACK B**	1.13.70	
Digital I/O Cable (if needed)	**GENERAL I/O J1**	1.13.8.1	
Digital Inputs and Analog Inputs Cable (if needed)	**GENERAL I/O J2**	1.13.8.2	
RS232 Communication Cable	**RS232**	1.13.9.1	
CAN Communication cable(s) (if needed)	**CAN (in) CAN (out)**	1.13.9.2	
PC for drive setup and tuning			
Motor data sheet or manual			

1.11. Unpacking the Drive Components

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

- The Cello servo drive
- The Composer software and software manual

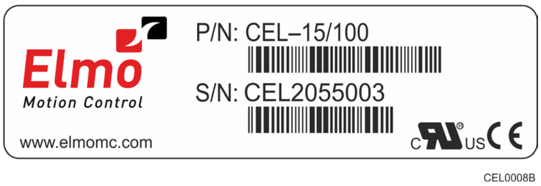
The Cello is shipped in a cardboard box with Styrofoam protection.

To unpack the Cello:

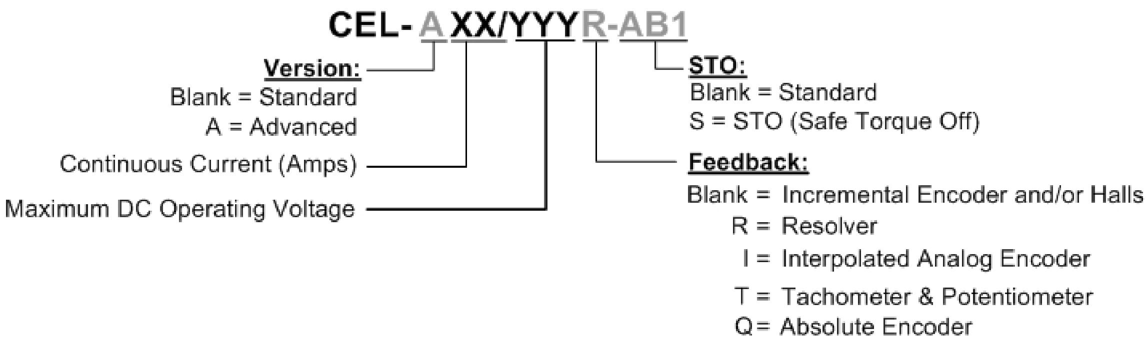
Carefully remove the servo drive from the box and the Styrofoam.

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.

To ensure that the Cello you have unpacked is the appropriate type for your requirements, locate the part number sticker on the side of the Cello. It looks like this:



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



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

1.12. Mounting the Cello

The Cello 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 Cello (see the diagram below).

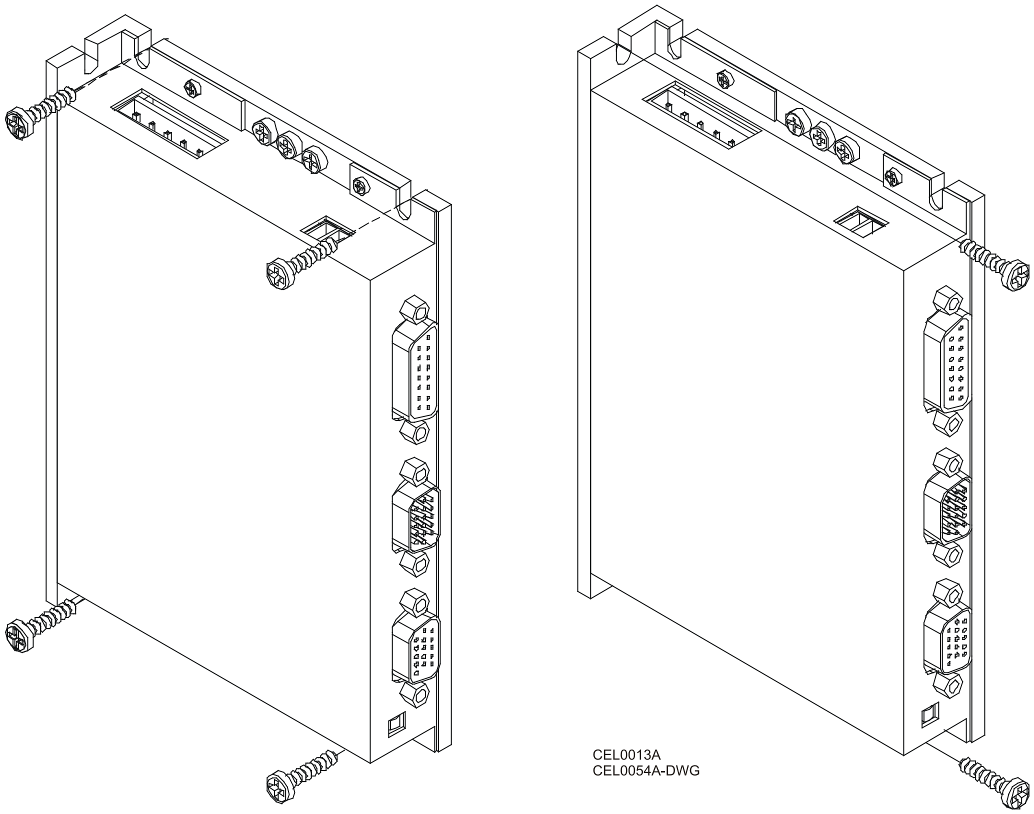


Figure 3: Mounting the Cello

1.13. Connecting the Cables

The Cello has ten connectors.

1.13.1. Wiring the Cello

Once the Cello 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 Cello.

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 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.

The following connectors are used for wiring the Cello.

Type	Function	Port	Connector Location
5-Pin Phoenix (1st two pins) (provided)	Power	VP+, PR	
5-Pin Phoenix (last 3 pins) (provided)	Motor	M1, M2, M3	
3 ground screws	Ground	PE, PE, PE	
2-Pin Phoenix (provided)	Optional Backup Supply	24 VDC	

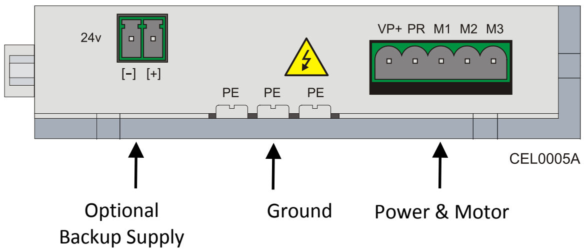


Table 1: Connectors on the "Bottom" of the Cello

Type	Function	Port	Connector Location
15-Pin D-Sub	Feedback A	Feedback A	
15-Pin D-Sub (high-density)	General I/O	J1	
15-Pin D-Sub (high-density)	General I/O	J2	

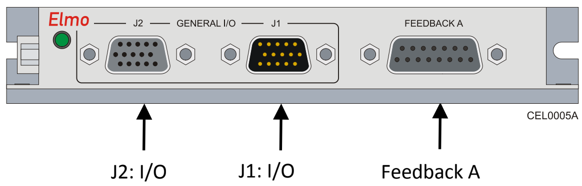


Table 2: Connectors on the "Front" of the Cello

Type	Function	Port	Connector Location
8-Pin RJ-45	CAN	CAN	
8-Pin RJ-45	CAN	CAN	
15-Pin D-Sub (high-density)	Feedback B	Feedback B	
8-Pin RJ-45	RS-232	RS-232	

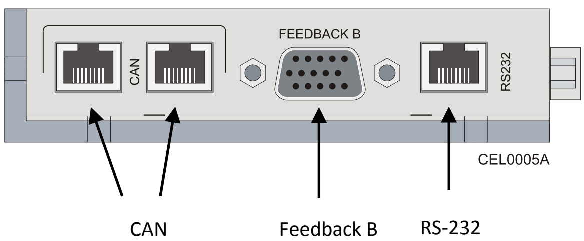


Table 3: Connectors on the "Top" of the Cello

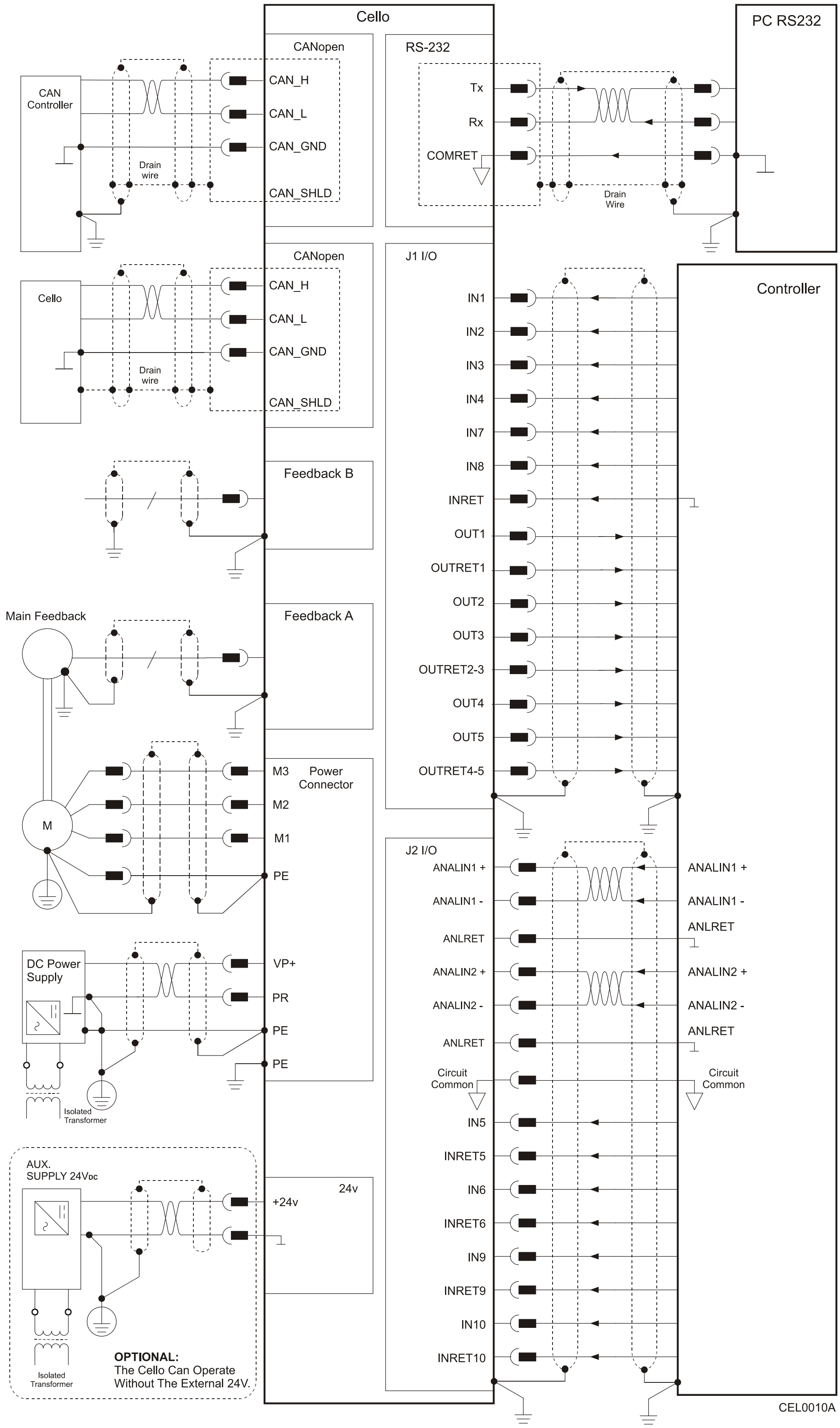


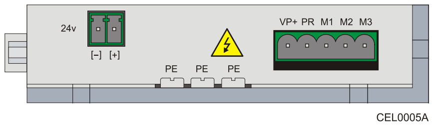
Figure 4: Cello Detailed Connection Diagram

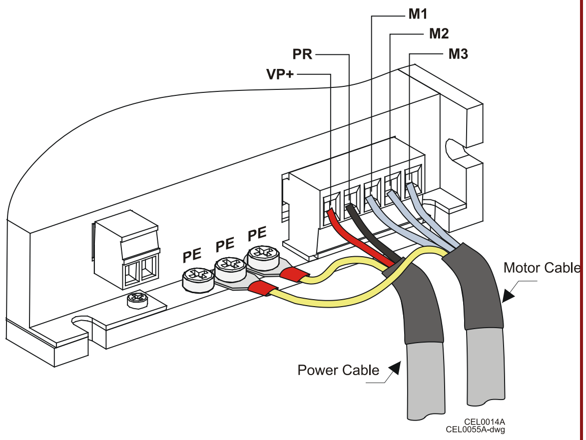
1.13.2. Connecting the Power Cables

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

Pin	Function	Cable	
VP+	Pos. Power input	Power	
PR	Power return	Power	
PE	Protective earth	Power	
		AC Motor Cable	**DC Motor Cable**
PE	Protective earth	Motor	Motor
M1	Motor phase	Motor	N/C
M2	Motor phase	Motor	Motor
M3	Motor phase	Motor	Motor

Pin Positions





Note: When connecting several motors, all must be wired in an identical manner.

Table 4: Connector for Main Power and Motor Cables

1.13.2.1. Connecting the Motor Cable

Connect the motor power cable to the M1, M2, and M3 terminals of the main power connector and the fourth wire to the PE (Protective Earth) on the heat sink (see diagram above). 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.

Connect the shield of the cable to the PE terminal on the Cello.

Be sure that the motor chassis is properly grounded.

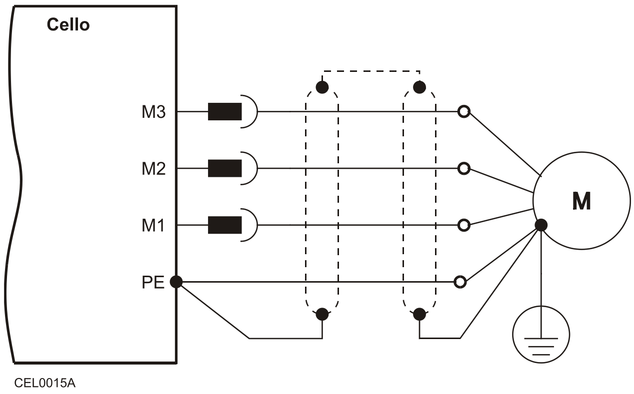


Figure 5: AC Motor Power Connection Diagram

1.13.2.2. Connecting the Main Power Cable

Connect the main power supply cable to the VP+ and PR terminals of the main power connector. Connect the Protective Earth wire to the PE terminal on the Cello's heat sink.

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 both ends of the cable shield to the closest ground connection, one end near the power supply and the other end to the PE terminal on the Cello's heat sink.

For safety reasons connect the PR of the power supply to the closest ground connection.

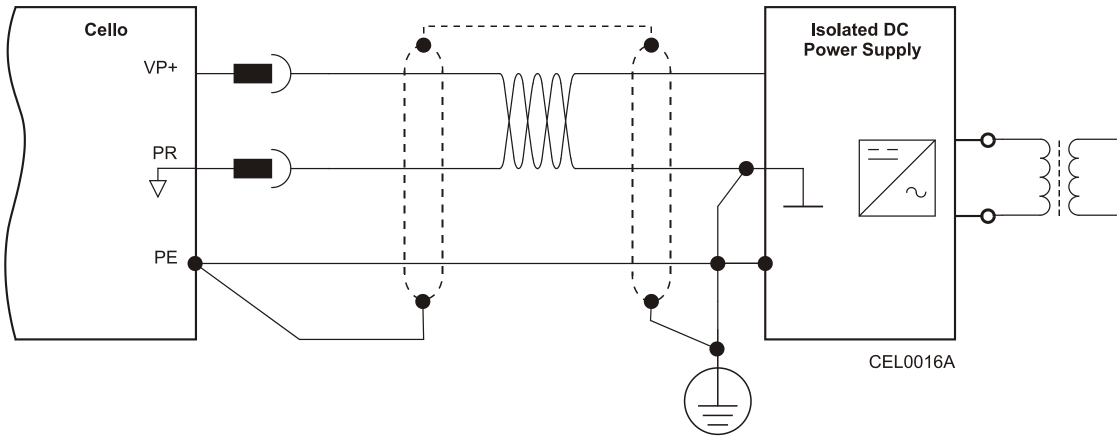


Figure 6: Main Power Supply Connection Diagram

1.13.3. Connecting the Optional Backup Supply Cable (24 V)

Power to the Cello is provided by a 10 to 195 VDC source. A “smart” control-supply algorithm enables the Cello to operate with the power supply only, *with no need for an auxiliary 24 volt supply*. If backup functionality is required for storing control parameters in case of power-outs, an external 24 VDC power supply can be connected, providing maximum flexibility and optional backup functionality when needed.

To connect the backup supply to the 24v port on the bottom of the Cello, use the 2-pin power plug provided with the Cello. *Remember, you are working with DC power; be sure to exercise caution.* The required voltage is 24 VDC.

Notes for 24 VDC backup supply connections:

Use a 24 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 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.

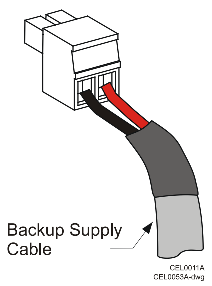
Pin	Signal	Function	Pin Positions
[+]	+24VDC	+24 VDC backup supply	
[-]	RET24VDC	Return (common) of the 24 VDC backup supply	

Table 5: Backup Cable Plug

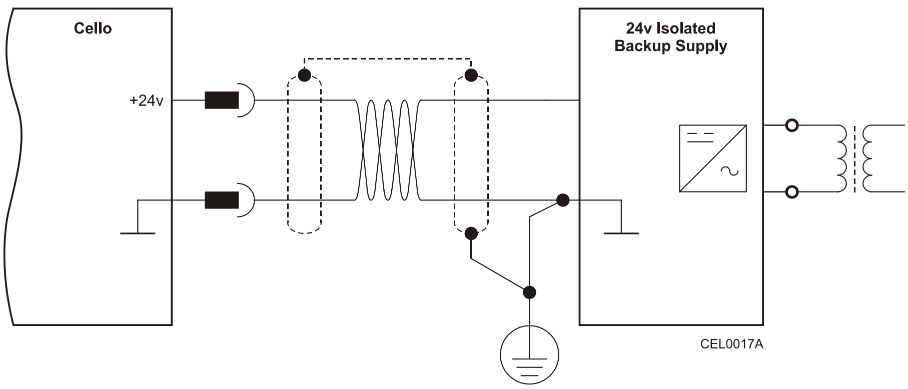


Figure 7: Backup Supply (24v) Connection Diagram

"Smart" Control Supply Options:

- Internal DC-to-DC converter that allows operation from DC power (no need for an auxiliary external 24 VDC supply for normal operation)
- 24 VDC supply for backing up the control parameters if DC power is shut off

1.13.4. Feedback and Control Cable Assemblies

The Cello features easy-to-use D-Sub type connections for all Control and Feedback cables. Instructions and diagrams describing how to assemble those cables are presented below.

1. Use 24, 26 or 28 AWG twisted-pair shielded cables (24 AWG cable is recommended). For best results, the shield should have aluminum foil covered by copper braid.

Use only a D-Sub connector with a **metal housing**.

Ideally, solder the drain wire to the connector body as shown in Figure 8.
However, the shield may also be attached without soldering, as long as the braid shield is in tight contact with the metal housing of the D-type connector.

On the motor side connections, ground the shield to the motor chassis.

On controller side connections, follow the controller manufacturer's recommendations concerning the shield.

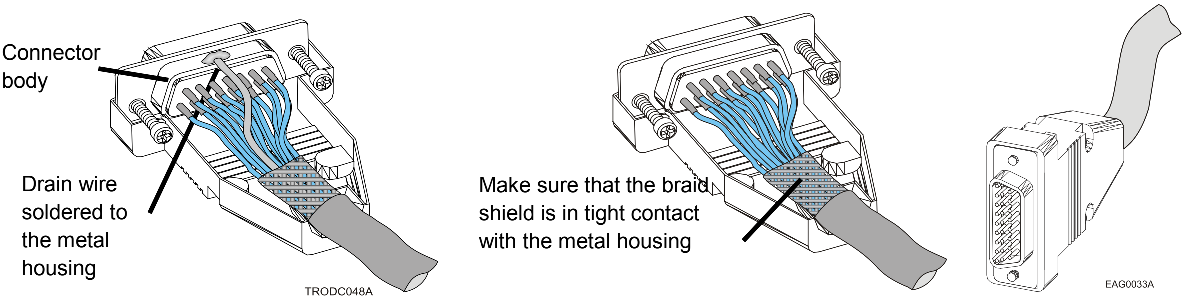


Figure 8: Feedback and Control Cable Assemblies

Note: **All D-Sub type connectors, used with the Cello, should be assembled in this way.**

1.13.5. Main Feedback Cable (FEEDBACK A)

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

The Cello 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 & Potentiometer
- Absolute encoder

FEEDBACK A on the "front" of the Cello has a 15-pin D-Sub socket. Connect the Main Feedback cable from the motor to FEEDBACK A using a 15-pin, D-Sub plug with a metal housing. When assembling the Main Feedback cable, follow the instructions in Section 1.13.4 (Feedback and Control Cable Assemblies).

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

Table 6: Main Feedback Cable Pin Assignments (Part A)

Absolute Encoders			
	CEL-XX/YYYQ		
Pin	**Signal**	**Heidenhain**	**Stegmann**
1	HC	Hall C	Hall C
2	HA	Hall A	Hall A
3	SUPRET	Supply return	Supply return
4	+5V	EnDat (Heidenhain) Encoder +5 supply	Halls supply +5V
5	A-	Sine A complement	Sine A
6	A+	Sine A	Sine A complement
7	DATA-	Data complement	Data complement
8	DATA+	DATA	DATA
9	SUPRET	Supply return	Supply return
10	HB	Hall B	Hall B
11	CLK-	CLOCK complement	-
12	+8V	-	Stegmann Encoder +8V supply 8 V @90 mA maximum
13	CLK+	CLOCK	-
14	B-	Cosine B complement	Cosine B complement
15	B+	Cosine B	Cosine B

Table 7: Main Feedback Cable Pin Assignments (Part B)

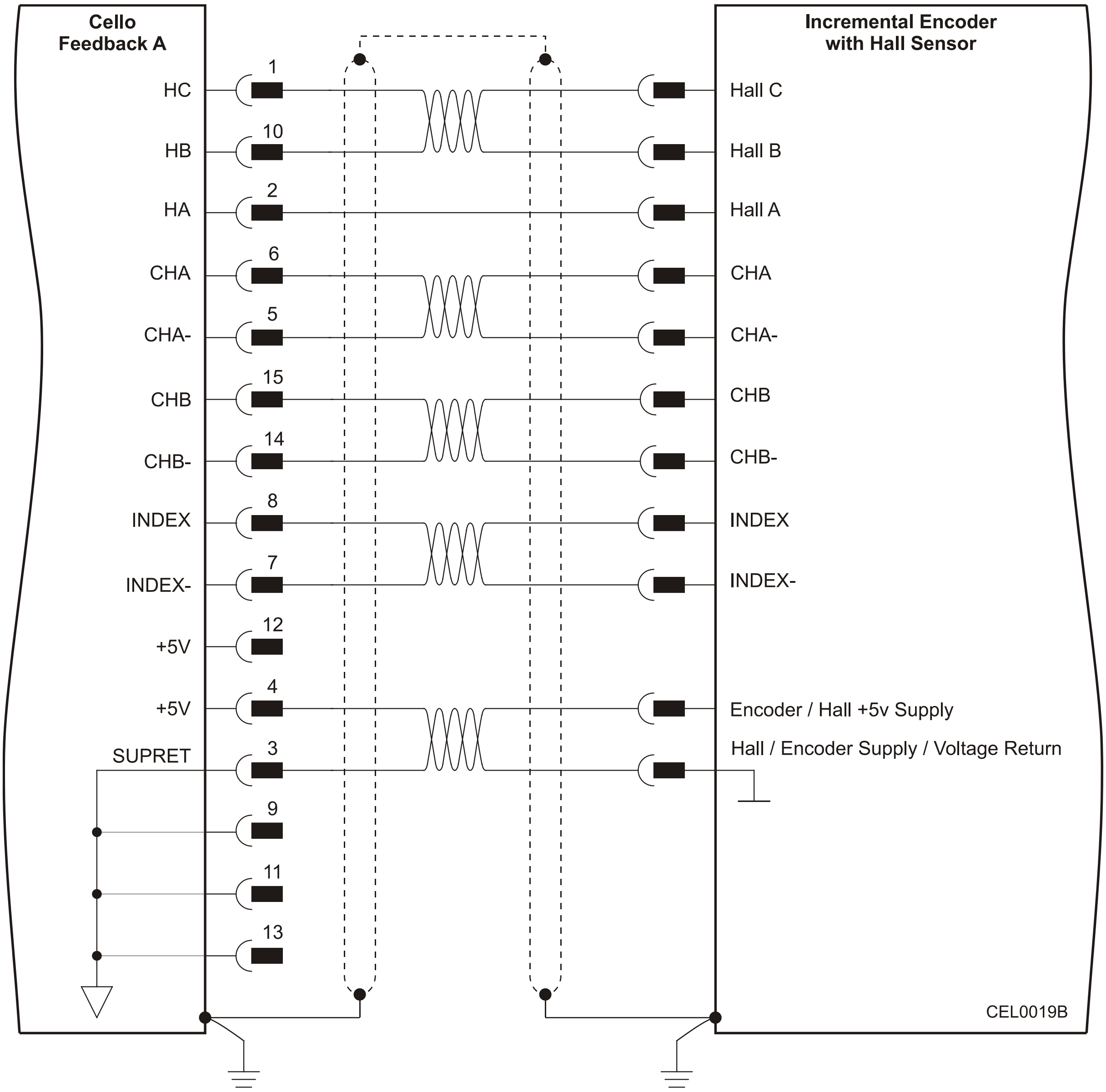


Figure 9: Main Feedback- Incremental Encoder Connection Diagram

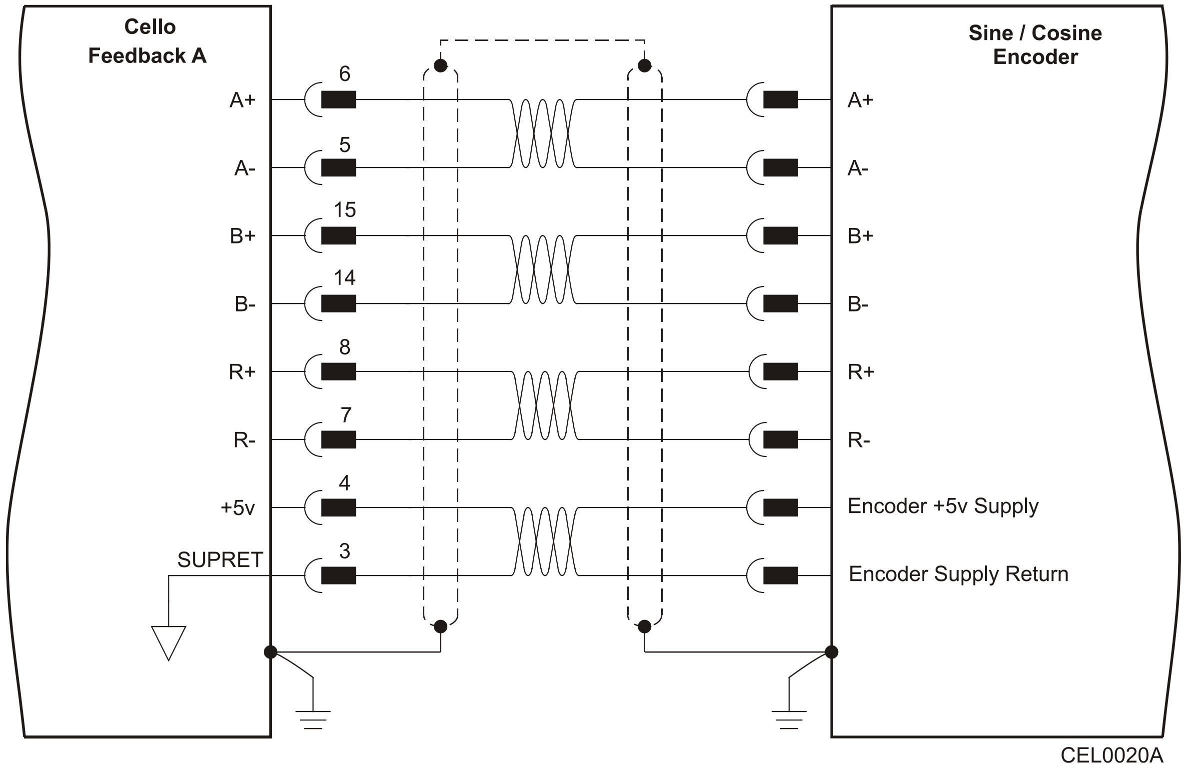


Figure 10: Main Feedback – Interpolated Analog (Sine/Cosine) Encoder Connection Diagram

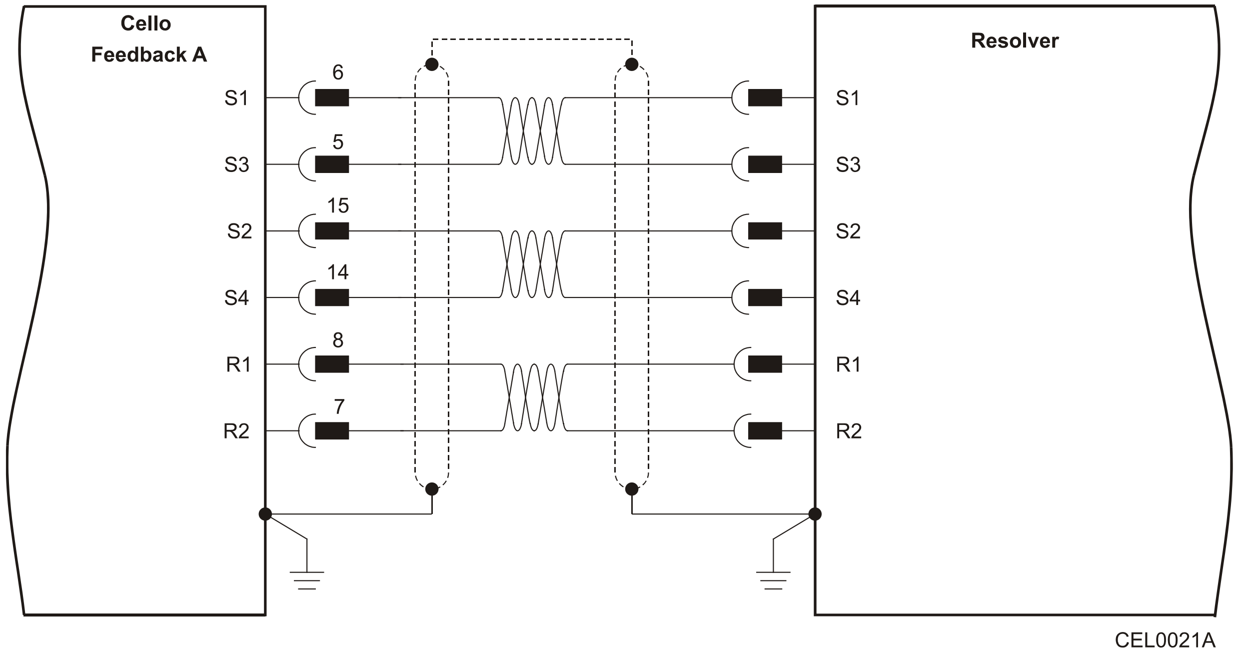


Figure 11: Main Feedback – Resolver Connection Diagram

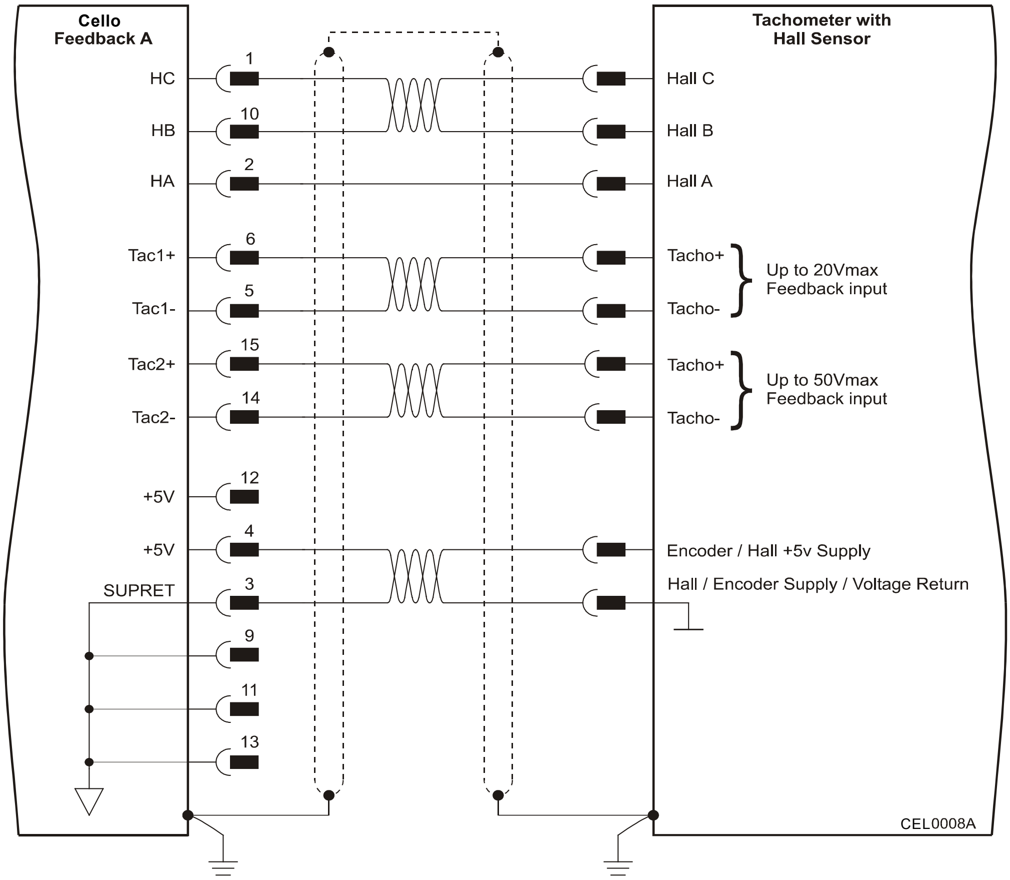


Figure 12: Main Feedback – Tachometer Feedback with Digital Hall Sensor Connection Diagram for Brushless Motors

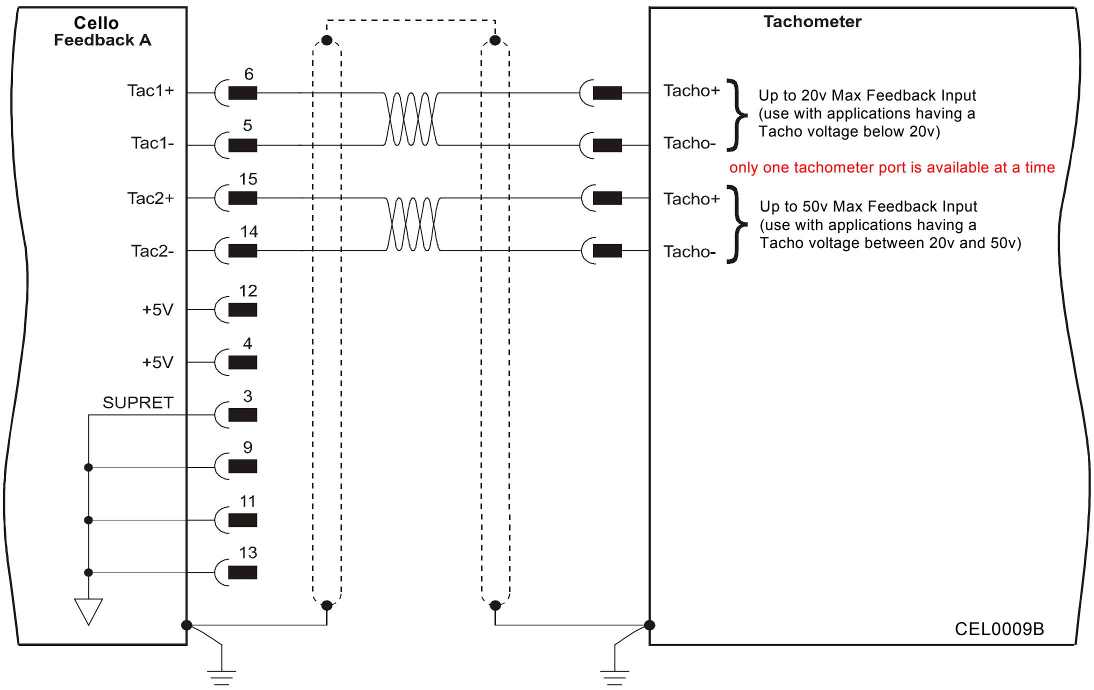


Figure 13: Main Feedback – Tachometer Feedback Connection Diagram for Brush Motors

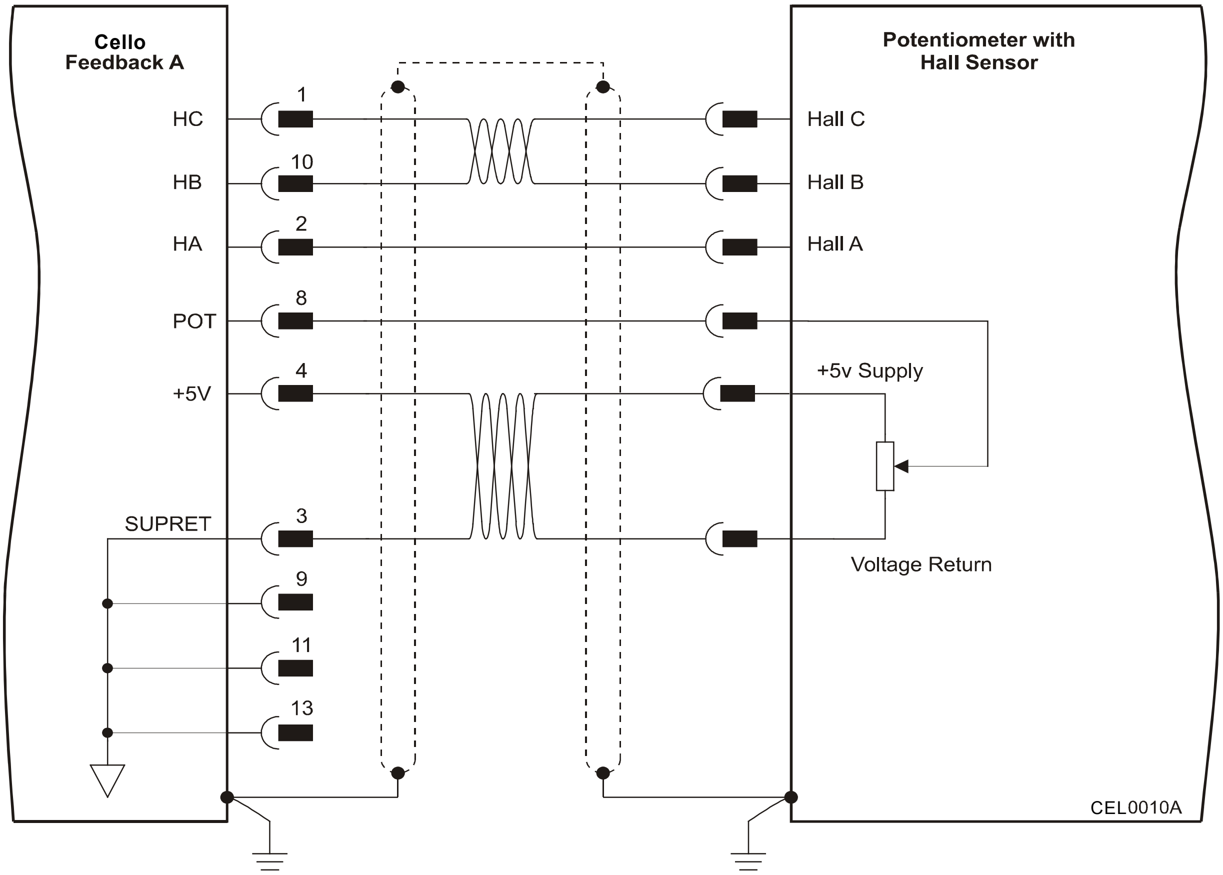


Figure 14: Main Feedback – Potentiometer Feedback with Digital Hall Sensor Connection Diagram for Brushless Motors

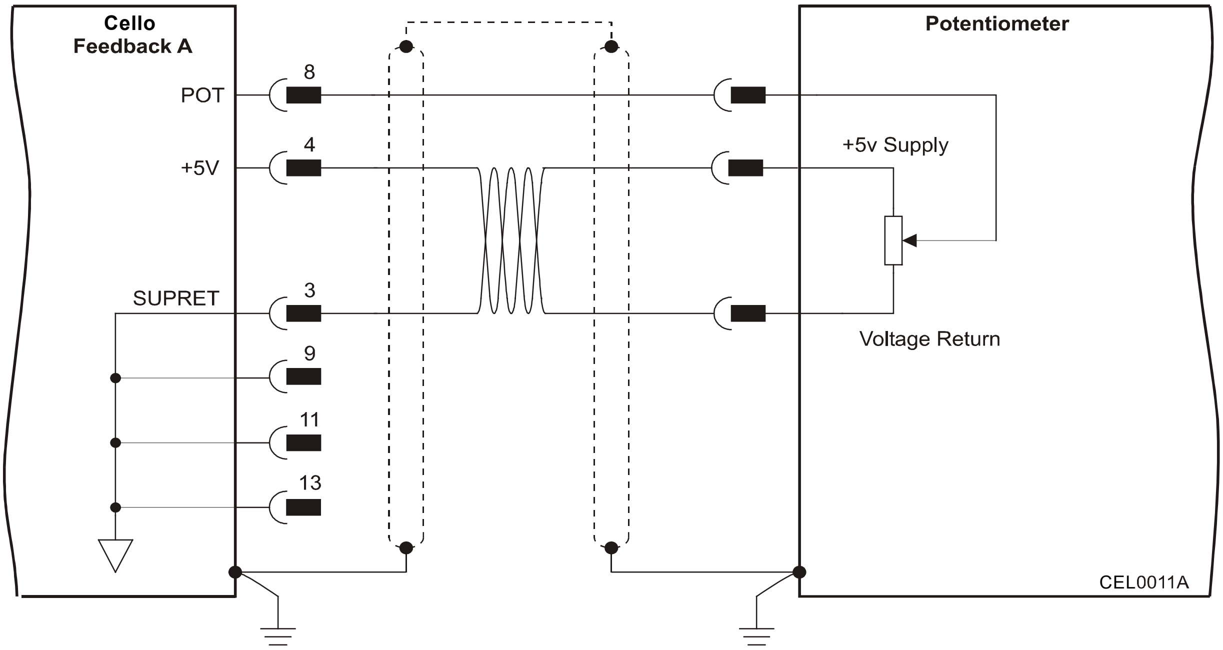


Figure 15: Main Feedback – Potentiometer Feedback Connection Diagram for Brush Motors and Voice Coils

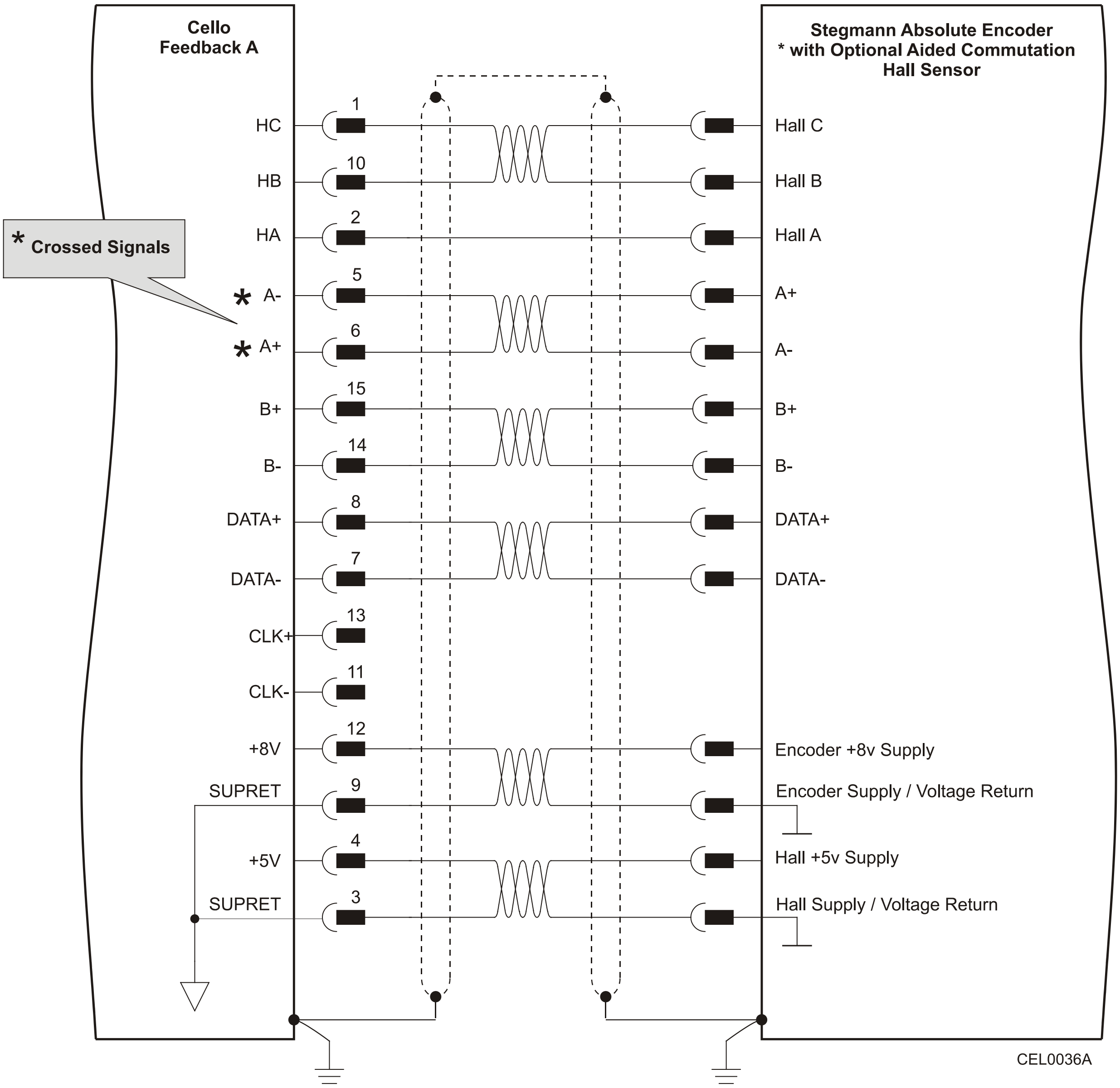


Figure 16: Main Feedback – Stegmann Feedback Connection Diagram

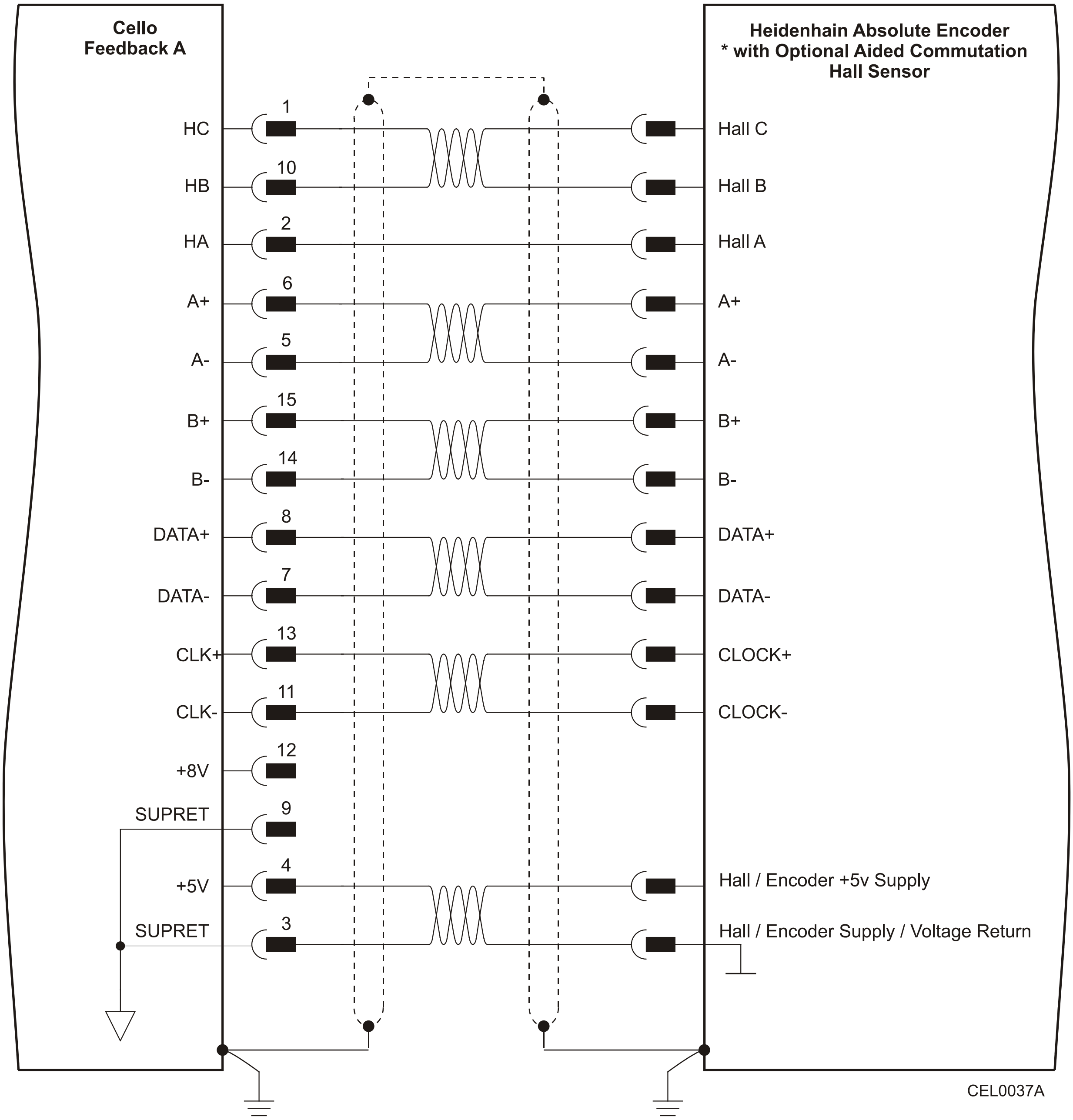
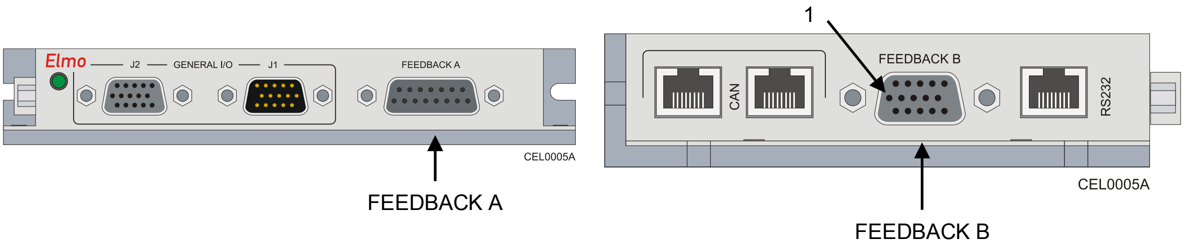


Figure 17: Main Feedback – Heidenhain Feedback Connection Diagram

1.13.6. 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 on the Cello, FEEDBACK B, has two ports, Port B1 (pins 1 to 5 and 10) and Port B2 (pins 6, 7 and 11 to 14). When used in combination with the Main Feedback port, FEEDBACK A, the ports can be set, by software, as follows:



Feedback A	Feedback B Ports B1 and B2		
Software Setting	**YA[4] = 4**	**YA[4] = 2**	**YA[4] = 0**
Incremental Encoder Input	★ **FEEDBACK A input:** Incremental Encoder **Port B1 output:** Differential and Buffered Main Encoder Signal **Port B2 output:** Same as B1	**FEEDBACK A input:** Incremental Encoder or Analog Encoder or Resolver or Tachometer or Potentiometer **Port B1:** Differential or Single-Ended Auxiliary Encoder **Port B2:** Differential and Buffered Auxiliary Encoder Signal	**FEEDBACK A input:** Incremental Encoder or Analog Encoder or Resolver or Tachometer or Potentiometer **Port B1:** Differential or Single-Ended Pulse and Direction Commands **Port B2:** Differential, Buffered and Pulse and Direction Signals
Interpolated Analog (Sin/Cos) Encoder Input	✶ **FEEDBACK A input:** Analog Encoder **Port B1 output:** Analog Encoder Position Data Emulated in Incremental Encoder Format (signals are quadrature, differential and buffered) **Port B2 output:** Same as B1		
Resolver Input	✷ **FEEDBACK A input:** Resolver **Port B1 output:** Resolver Position Data Emulated in Incremental Encoder Format (signals are quadrature, differential and buffered) **Port B2 output:** Same as B1		
Tachometer Input	**FEEDBACK A input:** Tachometer **Port B1 output:** Tachometer Position Data Emulated in Incremental Encoder Format (signals are quadrature, differential and buffered) **Port B2 output:** Same as B1		

FEEDBACK A	FEEDBACK B Ports B1 and B2		
Software Setting	**YA[4] = 4**	**YA[4] = 2**	**YA[4] = 0**
Potentio-meter Input	**FEEDBACK A input:** Potentiometer **Port B1 output:** Potentiometer Position Data Emulated in Incremental Encoder Format (signals are quadrature, differential and buffered) **Port B2 output:** Same as B1	**FEEDBACK A input:** Incremental Encoder or Analog Encoder or Resolver or Tachometer or Potentiometer **Port B1:** Differential or Single-Ended Auxiliary Incremental Encoder **Port B2:** Differential and Buffered Auxiliary Encoder Signal	**FEEDBACK A input:** Incremental Encoder or Analog Encoder or Resolver or Tachometer or Potentiometer **Port B1:** Differential or Single-Ended Pulse and Direction Commands **Port B2:** Differential Buffered Pulse and Direction Signals
Typical Applications	★ Any application where the main encoder is used, not only for the drive, but also for other purposes such as position controllers and/or other drives. ✶ Analog Encoder applications where position data is required in the Encoder's quadrature format. ✸ Resolver applications where position data is required in the Encoder's quadrature format.	Any application where two feedbacks are used by the drive. Port B1 serves as an input for the auxiliary incremental encoder (differential or single-ended). Port B2 is used to output differential buffered Auxiliary Incremental Encoder signals. For applications such as Follower, ECAM, or Dual Loop.	Port B1 serves as an input for Pulse & Direction commands (differential or single-ended). Port B2 is used to output differential buffered Pulse & Direction signals.

1.13.7. Auxiliary Feedback (FEEDBACK B)

When using one of the auxiliary feedback options, the relevant functionality of FEEDBACK B ports are software selected for that option. Refer to the *SimplIQ Command Reference Manual* for detailed information about FEEDBACK B setup.

1.13.7.1. Main Encoder Buffered Outputs or Emulated Encoder Outputs Option on FEEDBACK B (YA[4]=4)

Through FEEDBACK B (Ports B1 and B2) the Cello can provide **two simultaneous buffered main, or emulated, encoder signals** to other controllers or drives. This option can be used when:

- The Cello is used as a current amplifier to provide position data to the position controller.
- The Cello is used in velocity mode, to provide position data to the position controller.
- The Cello is used as a master in Follower or ECAM mode.

Below are the signals on the Auxiliary Feedback ports when set up to run as a buffered outputs or emulated outputs of the main encoder (on FEEDBACK A):

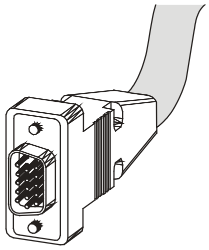
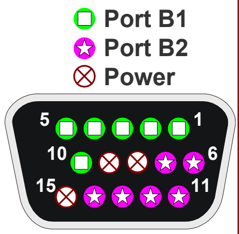
Port	Pin	Signal	Function	Pin Positions
B1	1	CHA	Auxiliary channel A high *output*	 **15-Pin High Density D-Sub Plug**
B1	2	CHA-	Auxiliary channel A low *output*	
B1	3	CHB	Auxiliary channel B high *output*	
B1	4	CHB-	Auxiliary channel B low *output*	
B1	5	INDEX	Auxiliary Index high *output*	
B2	6	CHAO	Buffered channel A output	
B2	7	CHAO-	Buffered channel A complement output	
PWR	8	+5V	Encoder supply voltage	
PWR	9	SUPRET	Encoder supply voltage return	 **15-Pin High Density D-Sub Socket**
B1	10	INDEX-	Auxiliary Index low *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	SUPRET	Supply return	

Table 8: Main Encoder Buffered Outputs or Emulated Encoder Outputs on FEEDBACK B - Pin Assignments

FEEDBACK B on the "top" of the Cello has a 15-pin high density D-Sub socket. Connect the Auxiliary Feedback cable, from the controller or other device, to FEEDBACK B using a 15-pin high density D-Sub plug with a metal housing. When assembling the Auxiliary Feedback cable, follow the instructions in Section 1.13.4 (Feedback and Control Cable Assemblies).

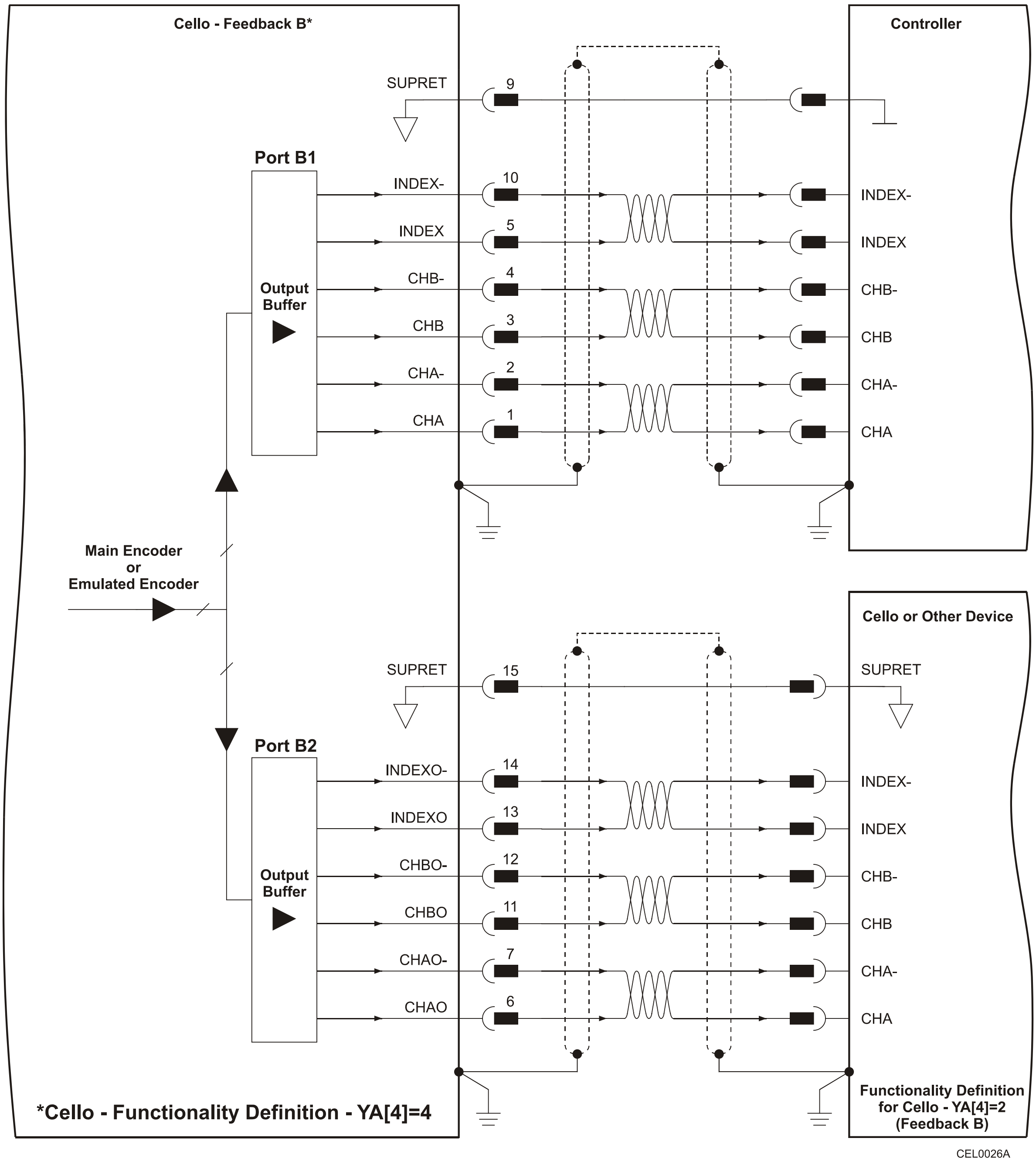
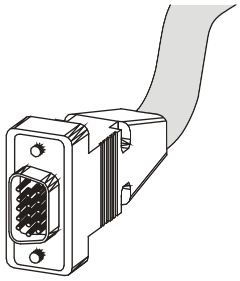
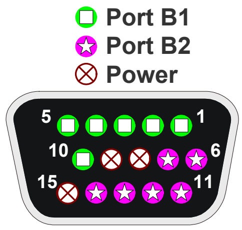


Figure 18: Main Encoder Buffered Output or Emulated Encoder Output on FEEDBACK B - Connection Diagram

1.13.7.2. Differential Auxiliary Encoder Input Option on FEEDBACK B (YA[4]=2)

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

Below are the signals on the Auxiliary Feedback port when set up to run as a differential auxiliary encoder input:

<table>
<tr><th>Port</th><th>Pin</th><th>Signal</th><th>Function</th><th>Pin Positions</th></tr>
<tr><td>B1</td><td>1</td><td>CHA</td><td>Auxiliary channel A high input</td><td rowspan="8">
15-Pin High Density D-Sub Plug</td></tr>
<tr><td>B1</td><td>2</td><td>CHA-</td><td>Auxiliary channel A low input</td></tr>
<tr><td>B1</td><td>3</td><td>CHB</td><td>Auxiliary channel B high input</td></tr>
<tr><td>B1</td><td>4</td><td>CHB-</td><td>Auxiliary channel B low input</td></tr>
<tr><td>B1</td><td>5</td><td>INDEX</td><td>Auxiliary Index high input</td></tr>
<tr><td>B2</td><td>6</td><td>CHAO</td><td>Buffered channel A output</td></tr>
<tr><td>B2</td><td>7</td><td>CHAO-</td><td>Buffered channel A complement output</td></tr>
<tr><td>PWR</td><td>8</td><td>+5V</td><td>Encoder supply voltage</td></tr>
<tr><td>PWR</td><td>9</td><td>SUPRET</td><td>Encoder supply voltage return</td><td rowspan="7">

15-Pin High Density D-Sub Socket</td></tr>
<tr><td>B1</td><td>10</td><td>INDEX-</td><td>Auxiliary Index low input</td></tr>
<tr><td>B2</td><td>11</td><td>CHBO</td><td>Buffered channel B output</td></tr>
<tr><td>B2</td><td>12</td><td>CHBO-</td><td>Buffered channel B complement output</td></tr>
<tr><td>B2</td><td>13</td><td>INDEXO</td><td>Buffered Index output</td></tr>
<tr><td>B2</td><td>14</td><td>INDEXO-</td><td>Buffered Index complement output</td></tr>
<tr><td>PWR</td><td>15</td><td>SUPRET</td><td>Supply return</td></tr>
</table>

Table 9: Differential Auxiliary Encoder Input Option on FEEDBACK B Pin Assignments

FEEDBACK B on the “top” of the Cello has a 15-pin high density D-Sub socket. Connect the Auxiliary Feedback cable from the feedback device to FEEDBACK B using a 15-pin, high density D-Sub plug with a metal housing. When assembling the Auxiliary Feedback cable, follow the instructions in Section 1.13.4 (Feedback and Control Cable Assemblies).

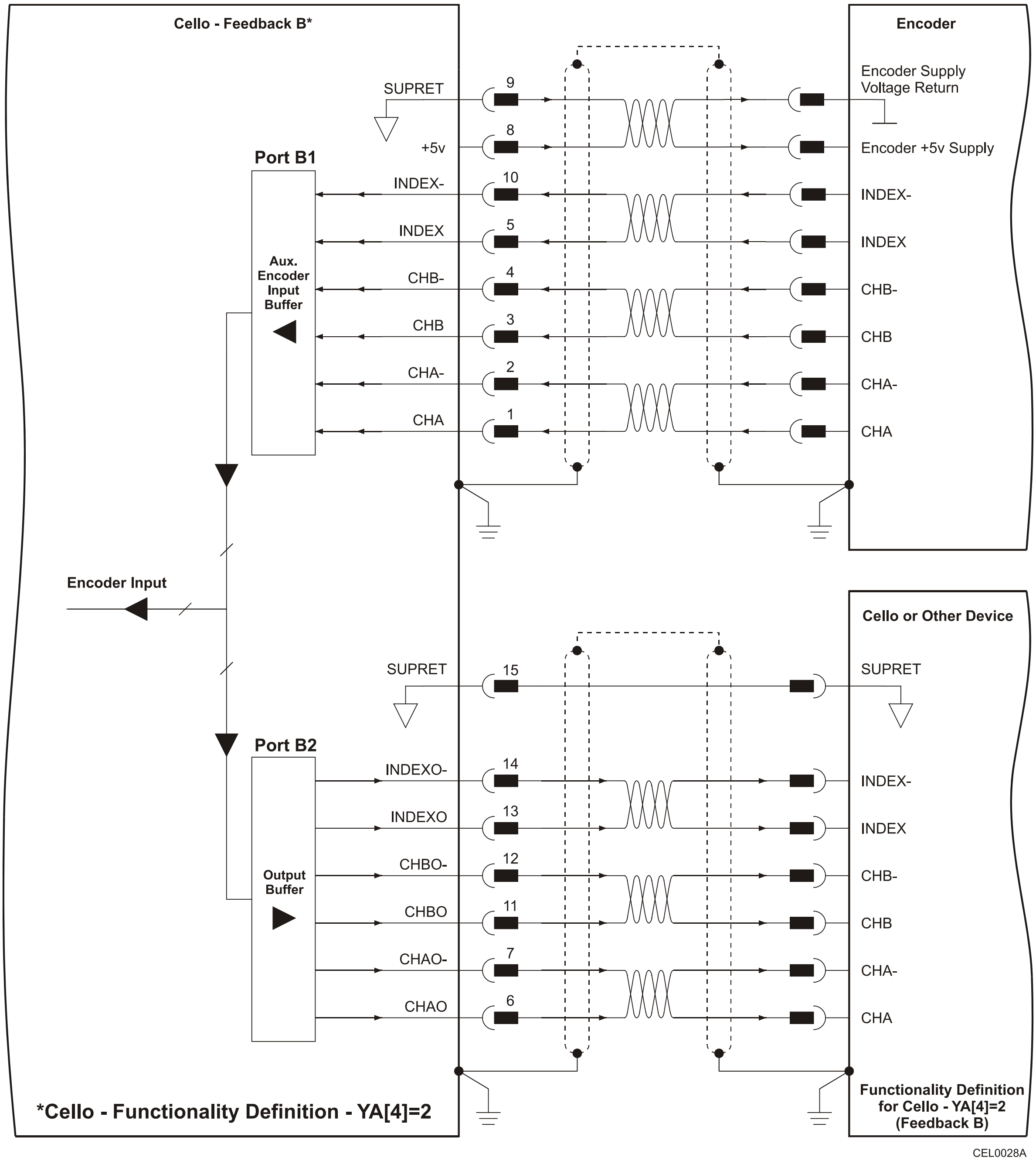


Figure 19: Differential Auxiliary Encoder Input Option on FEEDBACK B - Connection Diagram

1.13.7.3. Single-Ended Auxiliary Input Option on FEEDBACK B (YA[4]=2)

The Cello 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** for the next slave axis in Follower or ECAM mode.

Below are the signals on the Auxiliary Feedback ports when set up to run as a single-ended auxiliary input:

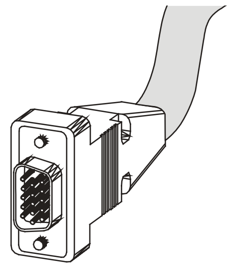
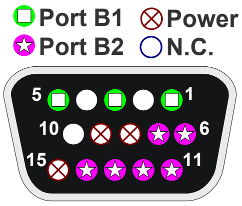
Port	Pin	Signal	Function	Pin Positions
B1	1	CHA	Auxiliary channel A high *input*	 15-Pin High Density D-Sub Plug
	2	NC	Do not connect this pin	
B1	3	CHB	Auxiliary channel B high *input*	
	4	NC	Do not connect this pin	
B1	5	INDEX	Auxiliary Index high *input*	
B2	6	CHAO	Channel A output	
B2	7	CHAO-	Channel A complement output	
PWR	8	+5V	Encoder supply voltage	
PWR	9	SUPRET	Encoder supply voltage return	 15-Pin High Density D-Sub Socket
	10	NC	Do not connect this pin	
B2	11	CHBO	Channel B output	
B2	12	CHBO-	Channel B complement output	
B2	13	INDEXO	Index output	
B2	14	INDEXO-	Index complement output	
PWR	15	SUPRET	Supply return	

Table 10: Single-Ended Auxiliary Encoder Option on FEEDBACK B - Pin Assignments

FEEDBACK B on the "top" of the Cello has a 15-pin high density D-Sub socket. Connect the Auxiliary Feedback cable from the feedback device to FEEDBACK B using a 15-pin, high density D-Sub plug with a metal housing. When assembling the Auxiliary Feedback cable, follow the instructions in Section 1.13.4 (Feedback and Control Cable Assemblies).

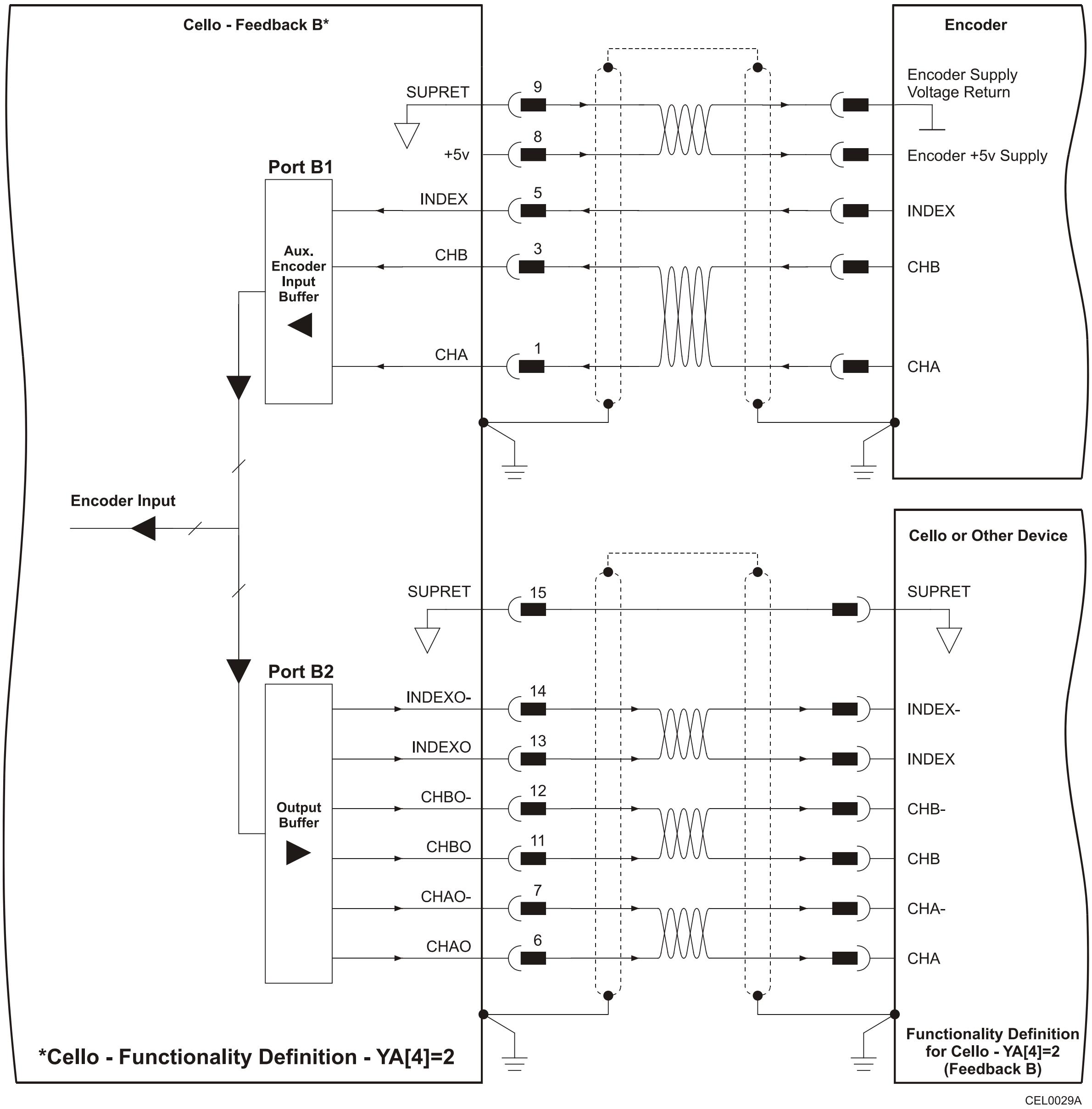


Figure 20: Single-Ended Auxiliary Input Option on FEEDBACK B - Connection Diagram

1.13.7.4. Pulse-and-Direction Input Option on FEEDBACK B (YA[4]=0)

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

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

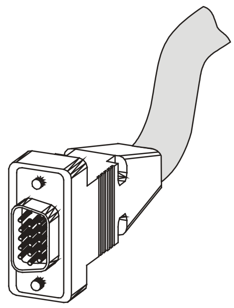
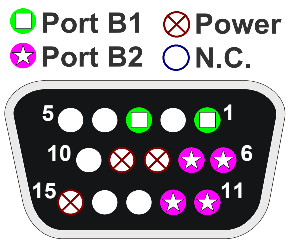
Port	Pin	Signal	Function	Pin Positions
B1	1	PULS/CHA	Pulse/Auxiliary channel A high *input*	 15-Pin D-Sub Plug
	2	NC	Do not connect this pin	
B1	3	DIR/CHB	Direction/Auxiliary channel B high *input*	
	4	NC	Do not connect this pin	
	5	NC	Do not connect this pin	
B2	6	CHAO	Channel A output	
B2	7	CHAO-	Channel A complement output	
PWR	8	+5V	Encoder supply voltage	
PWR	9	SUPRET	Encoder supply voltage return	 15-Pin D-Sub Socket
	10	NC	Do not connect this pin	
B2	11	CHBO	Channel B output.	
B2	12	CHBO-	Channel B complement output	
	13	NC	Do not connect this pin	
	14	NC	Do not connect this pin	
PWR	15	SUPRET	Supply return	

Table 11: Pulse-and-Direction Auxiliary Encoder Pin Assignment on FEEDBACK B

FEEDBACK B on the “top” of the Cello has a 15-pin high density D-Sub socket. Connect the Auxiliary Feedback cable from the Pulse and Direction Controller to FEEDBACK B using a 15-pin, high density D-Sub plug with a metal housing. When assembling the Auxiliary Feedback cable, follow the instructions in Section 1.13.4 (Feedback and Control Cable Assemblies).

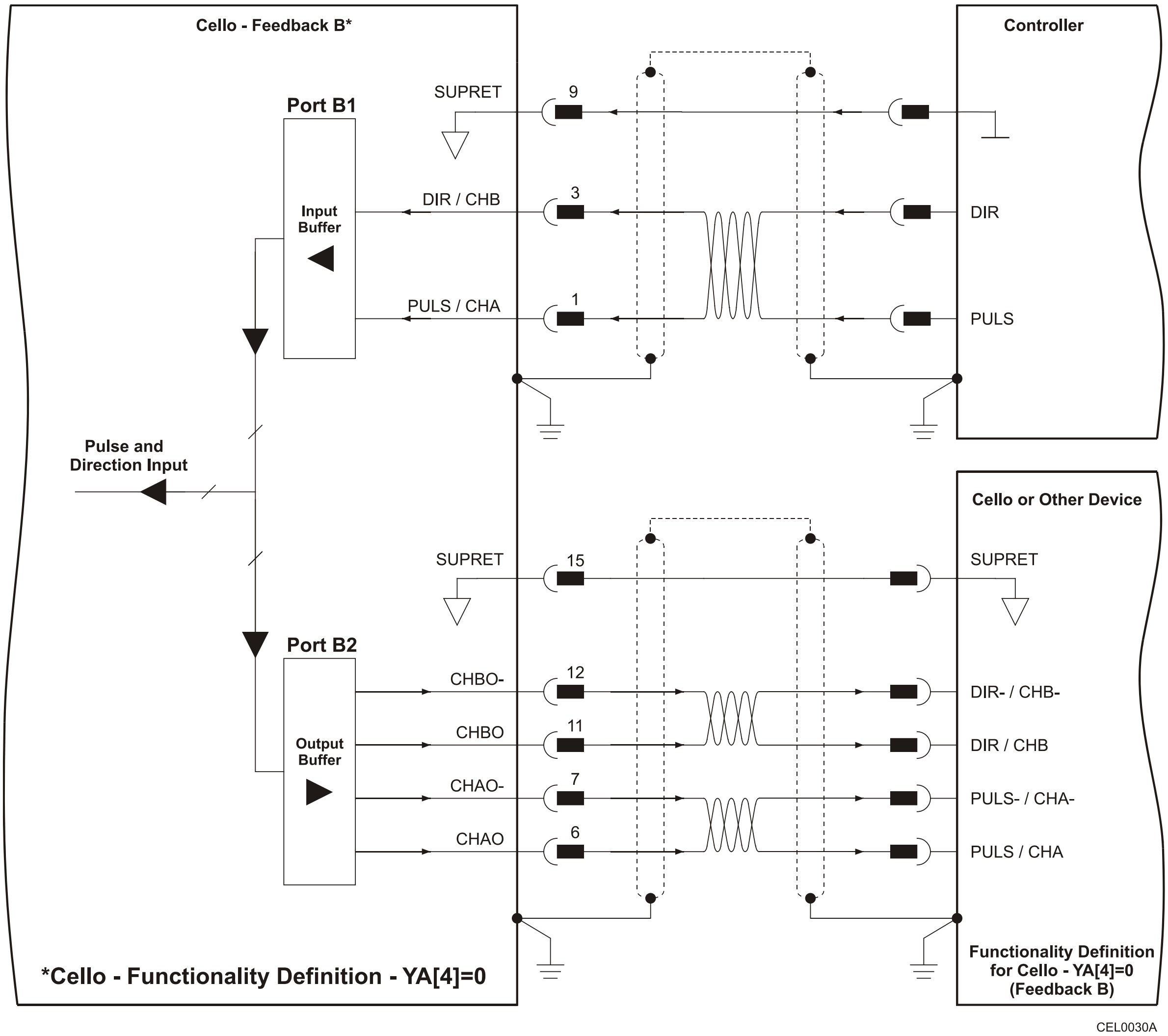


Figure 21: Pulse-and-Direction Input Option on FEEDBACK B - Connection Diagram

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

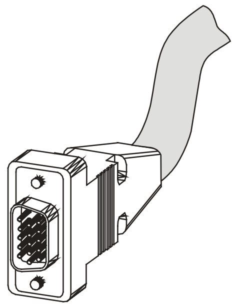
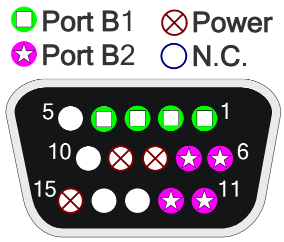
Port	Pin	Signal	Function	Pin Positions
B1	1	PULS/CHA	Pulse/Auxiliary channel A high *input*	 15-Pin D-Sub Plug
B1	2	PULS-/CHA-	Pulse-/Auxiliary channel A low *input*	
B1	3	DIR/CHB	Direction/Auxiliary channel B high *input*	
B1	4	DIR-/CHB-	Direction-/Auxiliary channel B low *input*	
	5	NC	Do not connect this pin	
B2	6	CHAO	Channel A output	
B2	7	CHAO-	Channel A complement output	
PWR	8	+5V	Encoder supply voltage	
PWR	9	SUPRET	Encoder supply voltage return	 15-Pin D-Sub Socket
	10	NC	Do not connect this pin	
B2	11	CHBO	Channel B output.	
B2	12	CHBO-	Channel B complement output	
	13	NC	Do not connect this pin	
	14	NC	Do not connect this pin	
PWR	15	SUPRET	Supply return	

Table 12: Differential Pulse-and-Direction Auxiliary Encoder Pin Assignment on FEEDBACK B

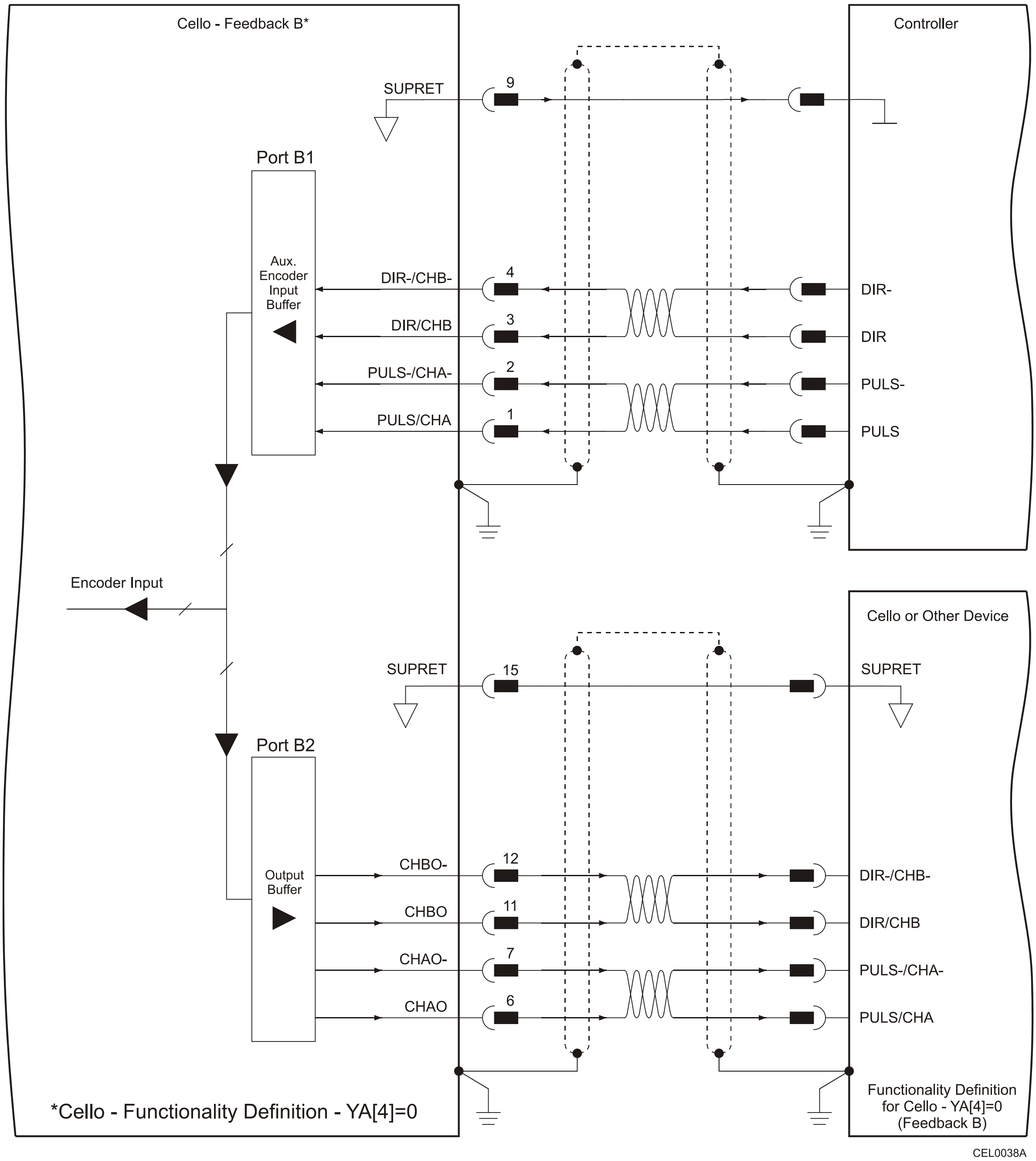


Figure 22: Differential Pulse-and-Direction Input Option on FEEDBACK B - Connection Diagram

1.13.8. I/O Cables

The Cello has two I/O ports, J1 and J2. J1 is a general I/O which can be used to connect 6 digital inputs and 5 digital outputs. J2 is an input port for connecting up to 4 separate digital inputs and 2 analog inputs:

I/O	J1 Port	J2 Port	Total
Digital Input	6	4	10
Digital Output	5	-	5
Analog Input	-	2	2

1.13.8.1. General I/O Port (J1)

Port J1 has a 15-pin high density D-Sub plug. When assembling this I/O cable, follow the instructions in Section 1.13.4 (Feedback and Control Cable Assemblies) using a 15-pin high density metal case D-Sub female connector (socket).

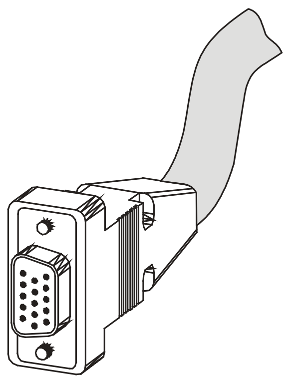
Pin	Signal	Function	Pin Positions
1	IN1	Programmable input 1	
2	IN2	Programmable input 2	
3	IN3	Programmable input 3	
4	OUT2	Programmable output 2	
5	OUT3	Programmable output 3	
6	IN4	Programmable input 4	
7	IN7	Programmable input 7	
8	IN8	Programmable input 8	
9	INRET	General input return	
10	OUTRET2-3	Programmable output return 2 & 3	
11	OUT4	Programmable output 4	
12	OUTRET4-5	Programmable output return 4 & 5	
13	OUT5	Programmable output 5	
14	OUT1	Programmable output 1	
15	OUTRET 1	Programmable output return 1	

Table 13: J1 I/O Cable - Pin Assignments

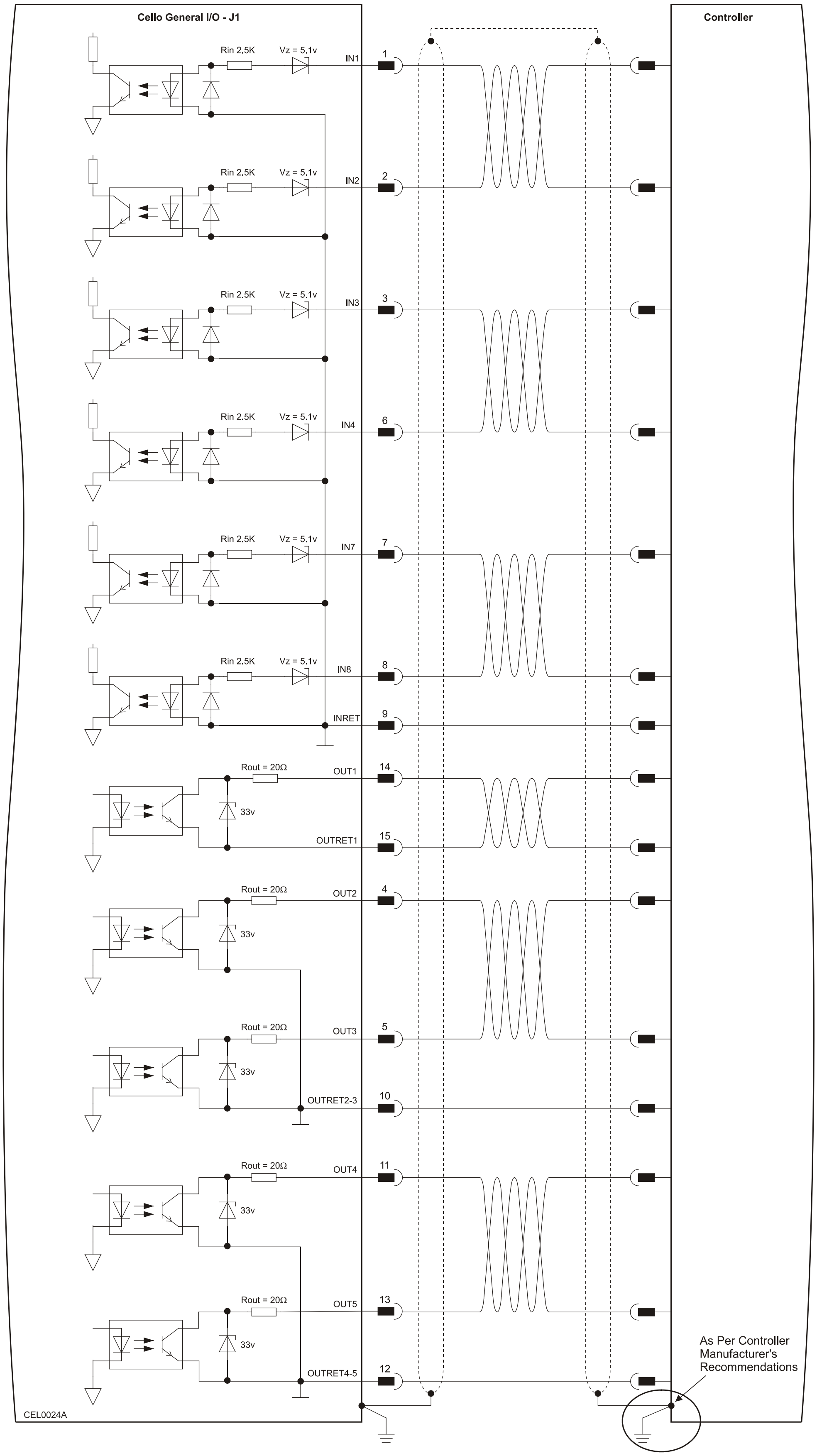


Figure 23: General J1 I/O Connection Diagram

1.13.8.2. General Input Port (J2)

Port J2 has a 15-pin high density D-Sub socket. When assembling this I/O cable, follow the instructions in Section 1.13.4 (Feedback and Control Cable Assemblies) using a 15-pin high density metal case D-Sub male connector (plug).

Note: Analog Inputs 1 and 2 are functionally identical. However, note that the velocity and current commands can only be given on Analog Input 1.

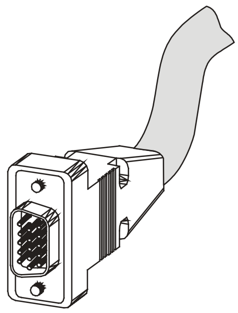
Pin	Signal	Function	Pin Positions
1	IN5	Programmable input 5 (high-speed input)	
2	IN6	Programmable input 6 (high-speed input)	
3	IN9	Programmable input 9	
4	IN10	Programmable input 10	
5	ANLIN1+	Analog input 1	
6	INRET5	Programmable input return 5 (high-speed input)	
7	INRET6	Programmable input return 6 (high-speed input)	
8	INRET9	Programmable input return 9	
9	INRET10	Programmable input return 10	
10	ANLIN1-	Analog input 1	
11	ANLIN2+	Analog input 2	
12	ANLIN2-	Analog input 2	
13	ANLRET	Analog return	
14	ANLRET	Analog return	
15	SUPRET	Supply return	

Table 14: General Input J2 Cable - Pin Assignments

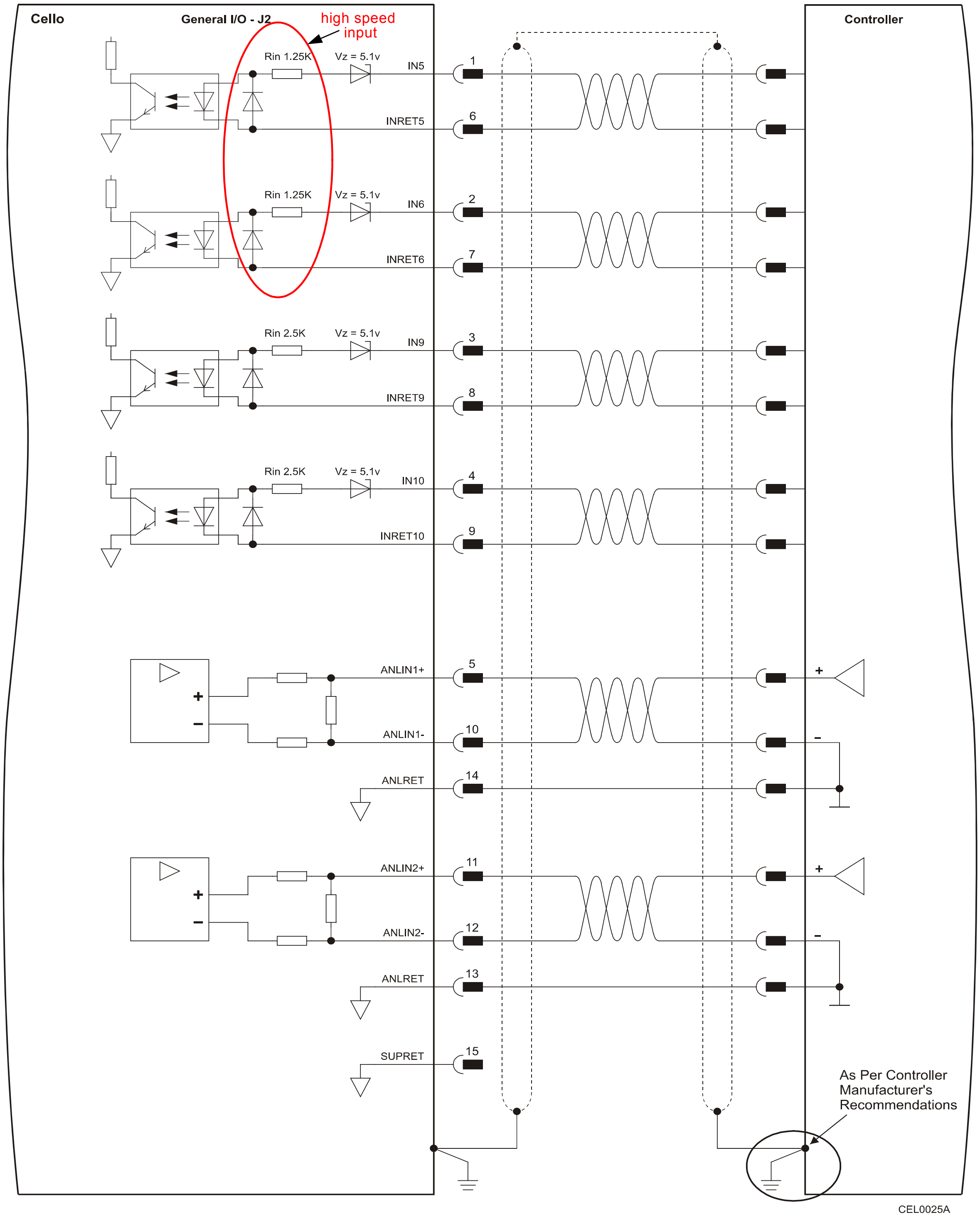


Figure 24: General Input J2 Connection Diagram

1.13.9. Communication Cables

The communication cables use an 8-pin RJ-45 plug that connect to the RS-232 and CAN ports on the “top” of the Cello.

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

a. RS-232, full duplex

CAN

RS-232 communication requires a standard, commercial 3-core null-modem cable connected from the Cello 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.

1.13.9.1. RS-232 Communication

Notes for connecting the RS-232 communication cable:

Use a 26 or 28 AWG twisted pair shielded cable. The shield should have aluminum foil 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 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.

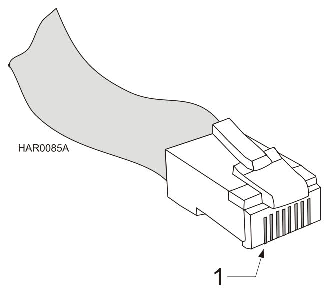
Pin	Signal	Function	Pin Locations
1, 2	N/A	—	
3	Tx	RS-232 transmit	
4	N/A	—	
5	COMRET	Communication return	
6	Rx	RS-232 receive	
7, 8	N/A	—	

Table 15: RS-232 Cable - Pin Assignments

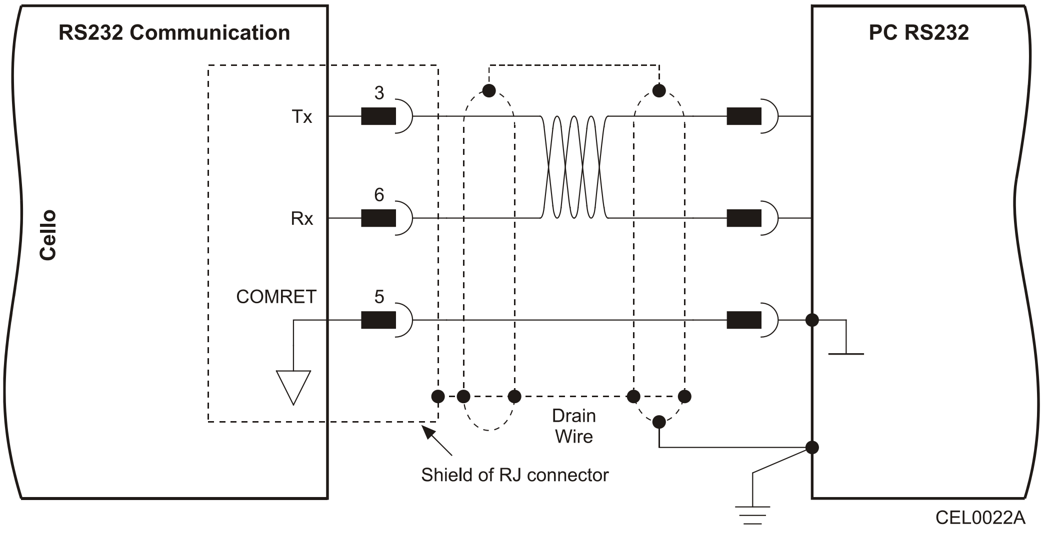


Figure 25: RS-232 Connection Diagram

1.13.9.2. 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 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 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.

Connect a termination 120-Ω resistor at each of the two ends of the network cable.

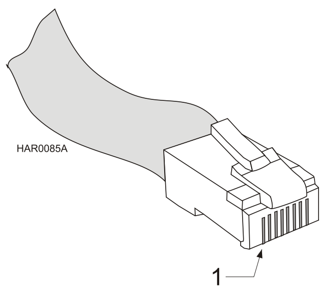
Pin	Signal	Function	Pin Positions
1	CAN_H	CAN_H busline (dominant high)	
2	CAN_L	CAN_L busline (dominant low)	
3	CAN_GND	CAN ground	
4, 5	N/A	—	
6	CAN_SHLD	Shield, connected to the RJ plug cover	
7	CAN_GND	CAN Ground	
8	N/A	—	

Table 16: CAN Cable – Pin Assignments

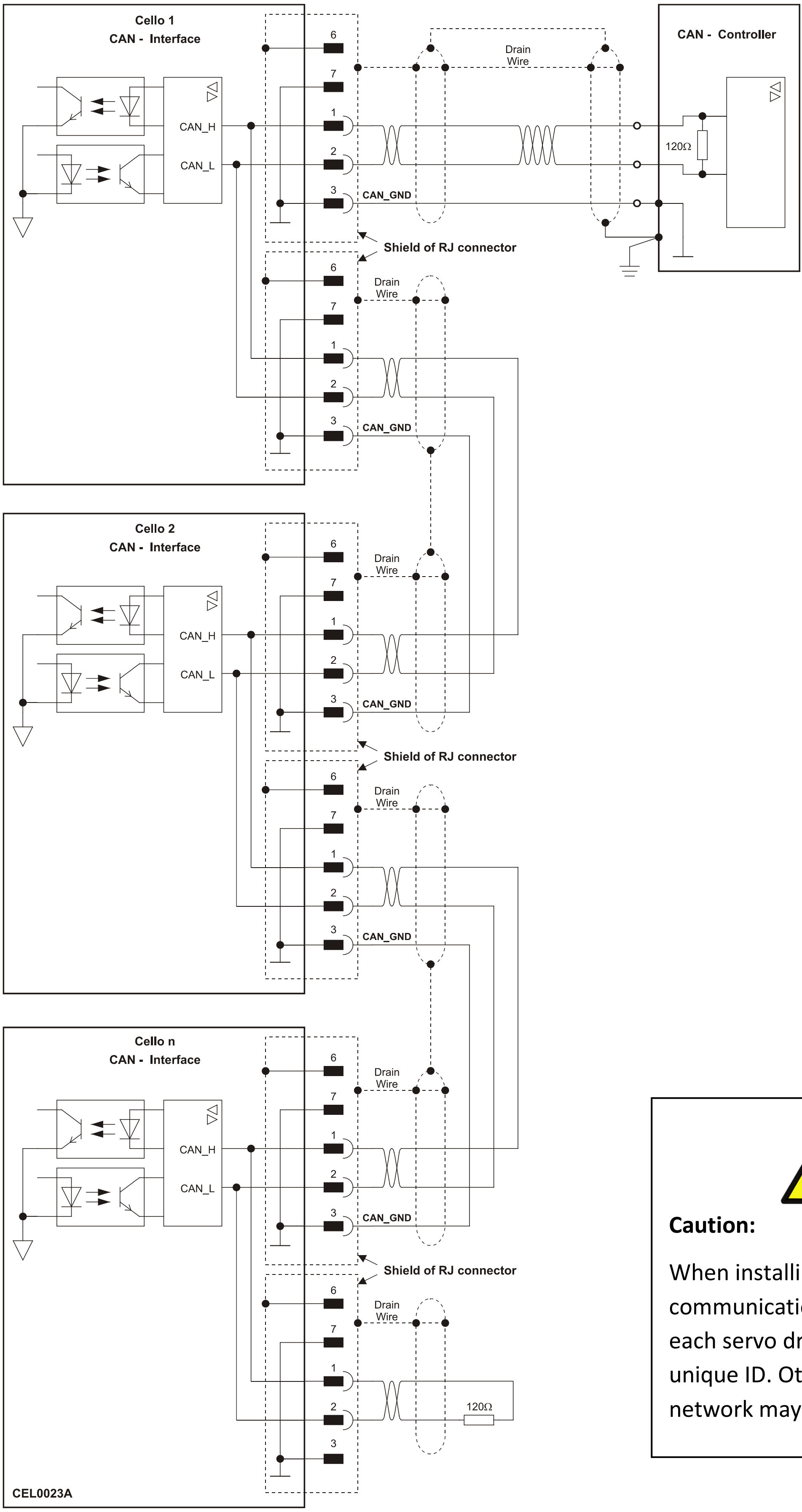


Figure 26: CAN Connection Diagram

Caution:

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

1.14. Powering Up

After the Cello has been mounted, check that the cables are intact. The Cello 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 Cello and that the proper plus-minus connections are in order.

1.15. Initializing the System

After the Cello 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*.

Technical Specifications

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

1.16. Features

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

1.16.1. 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

1.16.2. Advanced Positioning Motion Control Modes

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

1.16.3. 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

1.16.4. Fully Programmable

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

1.16.5. 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
- Absolute 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
  - 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
- Tachometer, Potentiometer

1.16.6. Input/Output

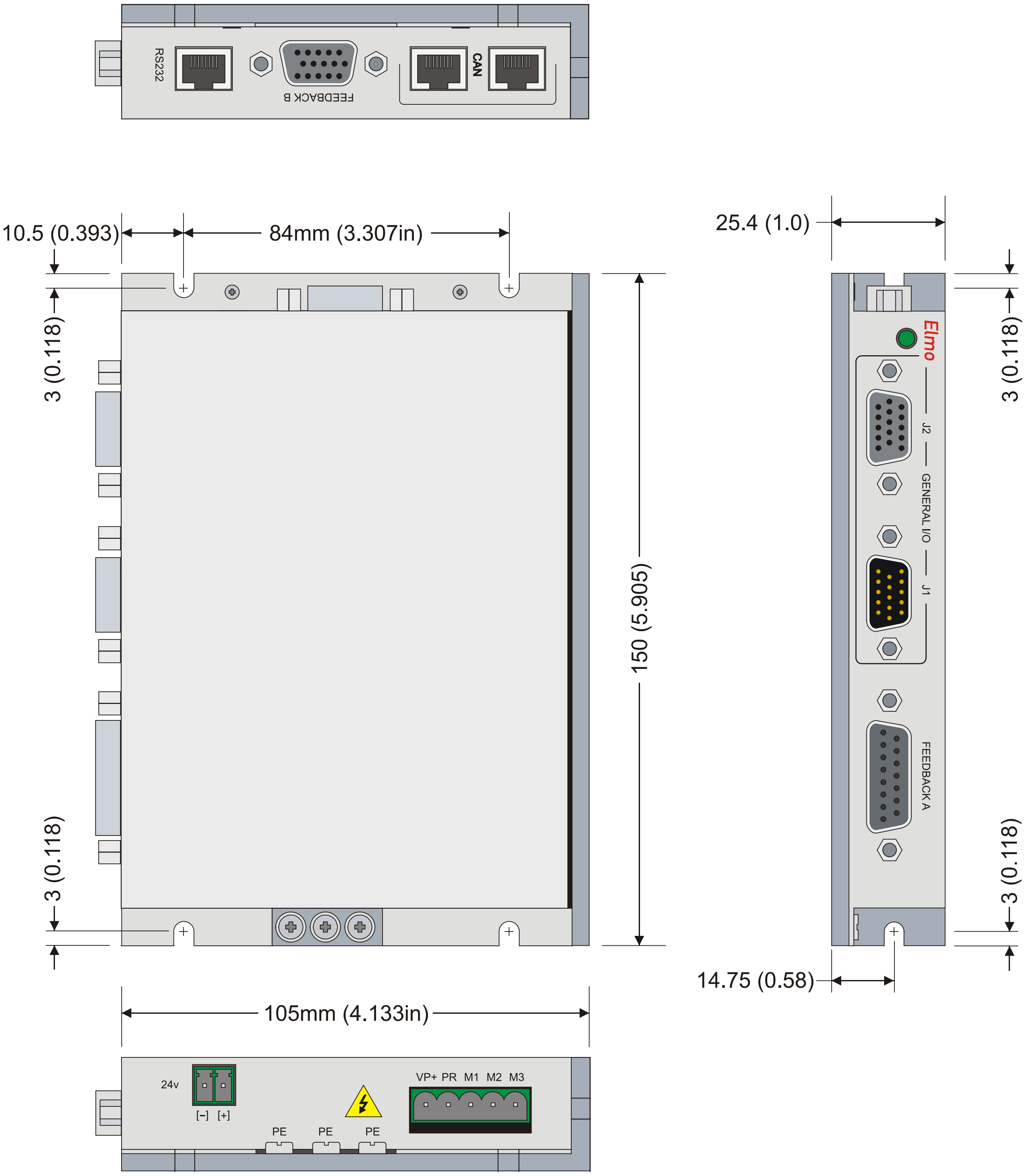
- Analog Inputs – up to 14-bit resolution
- Programmable digital inputs, optically isolated
  - Inhibit/Enable motion
  - Software and analog reference stop
  - Motion limit switches
  - Begin on input
  - Abort motion
  - General-purpose
  - Homing
- 2 Fast event capture inputs, optically isolated IN5-IN6
- 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
- Buffered and differential outputs of the auxiliary encoder

- Emulated output of the resolver or interpolated analog encoder
- Fast output compare (OC), optically isolated

1.16.7. Built-In Protection

- Software error handling
- Abort (hard stops and soft stops)
- Status reporting
- Protection against
  - Shorts between motor power outputs
  - Shorts between motor power outputs and power input/return
  - Failure of internal power supplies
  - Overheating
  - Over/Under voltage
  - Loss of feedback
  - Following errors
  - Current limits

1.17. Cello Dimensions



CEL0027A

1.18. Power Ratings

Feature	Units	5/60	10/60	15/60	15RMS/60	30/60	3/100	10/100	15/100	15RMS/100	30/100	2/200	6/200	10/200	15/200	15RMS/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	240	480	720	1000	1440	260	800	1200	1700	2400	360	960	1600	2400	3400
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	12														
Amplitude sinusoidal/DC continuous current	A	5	10	15	21	30	3.3	10	15	21	30	2.25	6	10	15	21
Sinusoidal continuous RMS current limit (Ic)	A	3.5	7.1	10.6	15	21.2	2.3	7.1	10.6	15	21.2	1.6	4.2	7.1	10.6	15
Peak current limit	A	2 x Ic														
Output power without additional heatsink	%	100				75	100					100		75		50
Weight	g (oz)	640 g (22.6 ounces)														
Dimensions	mm (in)	150 x 25.4 x 105 (5.9" x 1.0" x 4.1")														
Digital in/Digital out/ Analog in		10/5/2														
Mounting method		Wall mount (on back or on side)														

1.19. 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

1.20. Cello Connections

The following connectors are used for wiring the Cello.

Pins	Type	Maker & Part No.	Mating Connector	Port
5	5.00 mm Pitch Header and Plug	Phoenix Header MSTBA 2.5 HC/5-G	Phoenix Plug (supplied) MSTBT 2.5 HC/5-ST	VP+, PR M1, M2, M3
3	M4 screws			PE, PE, PE
2	3.81 mm Pitch Header and Plug	Phoenix Header MC 1.5/2-G-3.81	Phoenix Plug (supplied) MC 1.5/2-ST-3.81	24V
Connector Location				

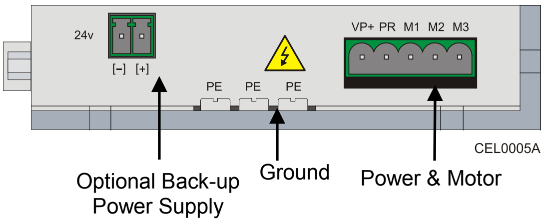


Table 17: Connectors on the Bottom of the Cello

Pins	Type	Port	Connector Location
15	D-Sub Socket	FEEDBACK A	
15	High Density D-Sub Plug	J1	
15	High Density D-Sub Socket	J2	

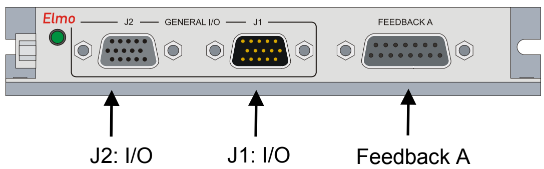


Table 18: Connectors on the Front of the Cello

Pins	Type	Port	Connector Location
8	RJ-45	CAN	
8	RJ-45	CAN	
15	High Density D-Sub Socket	FEEDBACK B	
8	RJ-45	RS-232	

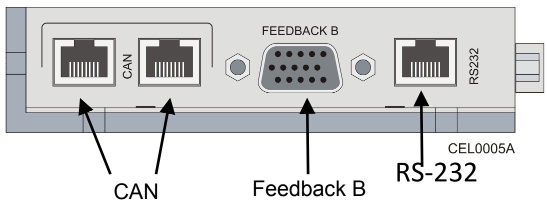


Table 19: Connectors on the Top of the Cello

1.20.1. Backup Supply (Optional)

Feature	Details
Auxiliary power supply	*DC source only*
Auxiliary supply input voltage	24 V ±20%
Auxiliary supply input power	10 W

Note: **The Cello can operate without a 24 Volt backup power supply**.

1.21. Control Specifications

1.21.1. Current Loop

Feature	Details
Controller type	Vector, digital
Compensation for bus voltage variations	"On-the-fly" 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

1.21.2. 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) **Note:** With all feedback options, 1/T with automatic mode switching is activated (gap, frequency and derivative).
Velocity sampling time	140 to 200 µsec (x2 current loop sample time)
Velocity sampling rate	Up to 8 kHz; default 5.5 kHz
Velocity command options	Analog Internally calculated by either jogging or step **Note:** All software-calculated profiles support on-the-fly changes.

1.21.3. Position Loop

Feature	Details
Controller type	"1-2-4" PIP
Position command options	Software Pulse and Direction
Position sampling time	280 to 400 µsec (x 4 current loop sample time)
Position sampling rate	Up to 4 kHz; default 2.75 kHz

1.22. Feedbacks

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

1.22.1. Feedback Supply Voltage

Feature	Details
Main encoder supply voltage	5 V ±5% @ 200 mA maximum
Auxiliary encoder supply voltage	5 V ±5% @ 200 mA maximum

1.22.2. Incremental Encoder Input

Feature	Details
Encoder format	A, B and Index Differential Quadrature
Interface:	RS-422
Input resistance	Differential: 120 Ω
Maximum incremental encoder frequency:	Maximum: 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

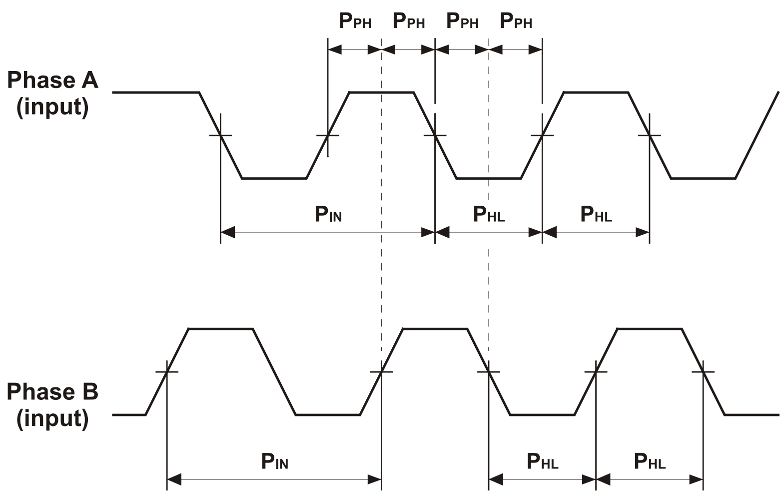


Figure 27: Encoder Phase Diagram

1.22.3. 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 also support open collector Halls)
Maximum frequency	f_{MAX} : 2 kHz

1.22.4. 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 error correction	Signal amplitudes mismatch Signal phase shift Signal offsets

1.22.5. 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 Cello
Reference current	up to ±50 mA

1.22.6. 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.

1.22.7. Potentiometer

Feature	Details
Potentiometer Format	Single-ended
Operating Voltage Range	0 to 5 V supplied by the Cello

Feature	Details
Potentiometer Resistance	100 Ω to 1 kΩ … above this range, linearity is affected detrimentally
Input Resistance	100 kΩ
Resolution	14 Bit

1.22.8. Encoder Outputs

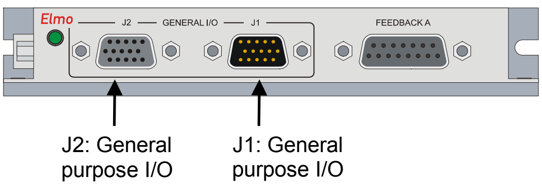
Feature	Details
Encoder output format	A, B, Index Differential outputs Quadrature
Interface	RS-422
Port B1 output current capability	Driving differential loads of 200 Ω on INDEX/INDEX-, CHB/CHB- and CHA/CHA- pairs
Port B2 output current capability	INDEXO/INDEXO-, CHBO/CHBO- and CHAO/CHAO- pairs are not loaded
Available as options	Two simultaneous buffered outputs of main-incremental encoder input Two simultaneous emulated encoder outputs of analog encoder input Two simultaneous emulated encoder outputs of resolver input Buffered output of auxiliary input
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

1.23. I/Os

The Cello has:

- 10 Digital Inputs
- 5 Digital Outputs
- 2 Analog Input

1.23.1. Digital Input Interfaces

Feature	Details
Type of input	Optically isolated Single ended PLC level
Input current	$I_{in} = \frac{V_{in} - 6.5\,V}{2500\,\Omega}$ * I_{in} = 2.2 mA for V_{in} = 12 V
Input current for high speed inputs	$I_{in} = \frac{V_{in} - 6.5\,V}{1250\,\Omega}$ * I_{in} = 4.4 mA for V_{in} = 12 V
High-level input voltage	12 V < V_{in} < 30 V, 24 V typical
Low-level input voltage	0 V < V_{in} < 6.5 V
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 < 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 (IN5 - IN6)	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.
Connector Location	
	

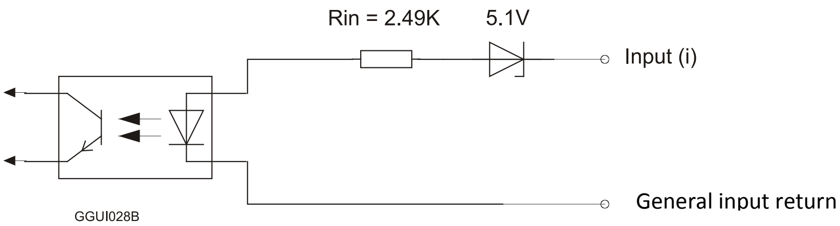
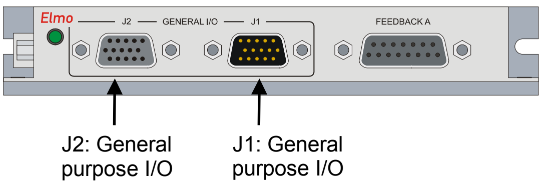


Figure 28: Digital Input Schematic

1.23.2. Digital Output Interface

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) ≤ 15 mA
VOL at maximum output voltage (low level)	V_{out} (on) ≤ 0.3 V + 0.02 * I_{out} (mA)
R_L	The external resistor R_L must be selected to limit the output current to no more than 15 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.
Connector Location	
	

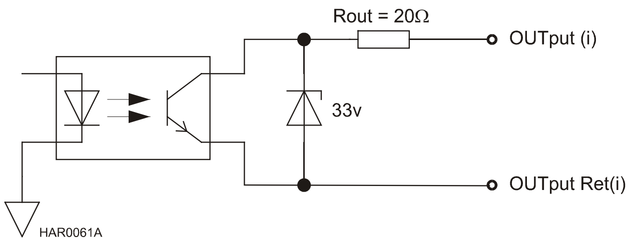
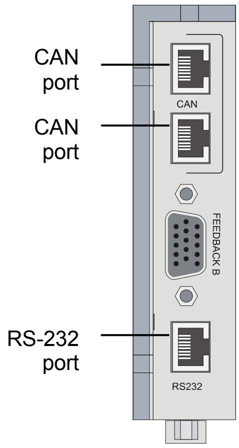


Figure 29: Digital Output Schematic

1.23.3. Analog Input

Feature	Details
Maximum operating differential voltage	± 10 V
Maximum absolute differential input voltage	± 16 V
Differential input resistance	3 kΩ
Analog input command resolution	14-bit

1.24. 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 115,200 bit/sec.	
CAN	**CAN bus Signals:** CAN_H, CAN_L, CAN_GND Maximum Baud Rate of 1 Mbit/sec. **Version:** DS 301 V4.01 **Device Profile** (drive and motion control): DS 402	

1.25. 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)

1.26. Mechanical Specifications

Feature	Details
Mounting method	Wall Mount
Overall dimensions	150 x 105 x 25.4 mm (5.9 x 4.13 x 1 in)
Weight	640 g (22.6 oz)

1.27. 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)