
ExtrIQ_{Line}

Falcon Digital Servo Drive Installation Guide



October 2017 (Ver. 1.503)



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 Falcon 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 registered trademarks of Elmo Motion Control Ltd.
- Information in this document is subject to change without notice.

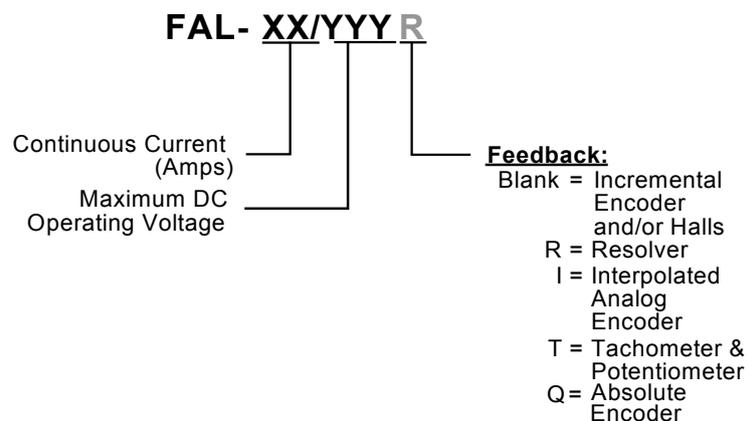
Document no. MAN-FALIG (Ver. 1.503)

Copyright © 2017

Elmo Motion Control Ltd.

All rights reserved.

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	Details	
1.0		Initial release
1.2	Aug 2008	Added 3.4.7.4: Differential Pulse-and-Direction Input
1.3	Sep 2008	MTCR 00-100-29: Added Table 7, Figure 16 and Figure 17
1.4	Mar 2010	MTCR 07-009-56: Added note to 3.4.8.2
1.5	July 2011	Formatted according to the new template
1.501	Feb 2013	Added a caution and recommendation on the type of cleaning solution to use for the Elmo unit.
1.502	July 2014	General format update
1.503	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	7
1.1. Warnings.....	8
1.2. Cautions.....	8
1.3. Directives and Standards.....	9
1.4. CE Marking Conformance.....	10
1.5. Warranty Information	10
Chapter 2: Introduction	11
2.1. <i>ExtrIQ</i> Product Family.....	11
2.2. Drive Description.....	12
2.3. Product Features	13
2.3.1. Current Control.....	13
2.3.2. Velocity Control	13
2.3.3. Position Control	13
2.3.4. Communication Options.....	13
2.3.5. Feedback Options.....	14
2.3.6. Fault Protection	14
2.4. System Architecture	15
2.5. How to Use this Guide.....	15
Chapter 3: Installation	17
3.1. Before You Begin	17
3.1.1. Site Requirements	17
3.1.2. Hardware Requirements	17
3.2. Unpacking the Drive Components.....	19
3.3. Mounting the Falcon	20
3.4. Connecting the Cables.....	21
3.4.1. Wiring the Falcon.....	21
3.4.2. Connecting the Power Cables.....	24
3.4.2.1. Connecting the Motor Cable	24
3.4.2.2. Connecting the Main Power Cable	25
3.4.3. Connecting the Optional Backup Supply Cable (24 V).....	26
3.4.4. Feedback and Control Cable Assemblies.....	27
3.4.5. Main Feedback Cable (FEEDBACK A)	27
3.4.6. Main and Auxiliary Feedback Combinations	35
3.4.7. Auxiliary Feedback (FEEDBACK B).....	36
3.4.7.1. Main Encoder Buffered Outputs or Emulated Encoder Outputs Option on FEEDBACK B (YA[4]=4).....	36
3.4.7.2. Differential Auxiliary Encoder Input Option on FEEDBACK B (YA[4]=2)	39
3.4.7.3. Single-Ended Auxiliary Input Option on FEEDBACK B (YA[4]=2)...	41

3.4.7.4.	Pulse-and-Direction Input Option on FEEDBACK B (YA[4]=0).....	43
3.4.8.	I/O Cables	47
3.4.8.1.	General I/O Port (J1).....	47
3.4.8.2.	General Input Port (J2)	49
3.4.9.	Communication Cables.....	51
3.4.9.1.	RS-232 Communication	51
3.4.9.2.	CAN Communication.....	52
3.5.	Powering Up	54
3.6.	Initializing the System.....	54
Chapter 4: Technical Specifications		55
4.1.	Features.....	55
4.1.1.	Motion Control Modes	55
4.1.2.	Advanced Positioning Motion Control Modes	55
4.1.3.	Advanced Filters and Gain Scheduling.....	55
4.1.4.	Fully Programmable.....	55
4.1.5.	Feedback Options	56
4.1.6.	Input/Output	56
4.1.7.	Built-In Protection	57
4.2.	Falcon Dimensions.....	58
4.3.	Power Ratings.....	59
4.4.	Environmental Conditions	60
4.5.	Falcon Connections	61
4.5.1.	Backup Supply (Optional)	61
4.6.	Control Specifications.....	63
4.6.1.	Current Loop.....	63
4.6.2.	Velocity Loop	64
4.6.3.	Position Loop	64
4.7.	Feedbacks	65
4.7.1.	Feedback Supply Voltage.....	65
4.7.2.	Incremental Encoder Input.....	65
4.7.3.	Digital Halls	66
4.7.4.	Interpolated Analog (Sine/Cosine) Encoder	66
4.7.5.	Resolver	67
4.7.6.	Tachometer.....	67
4.7.7.	Potentiometer	68
4.7.8.	Encoder Outputs.....	68
4.8.	I/Os	69
4.8.1.	Digital Input Interfaces	69
4.8.2.	Digital Output Interface.....	70
4.8.3.	Analog Input	71
4.9.	Communications.....	72
4.10.	Pulse-Width Modulation (PWM).....	72
4.11.	Mechanical Specifications	72
4.12.	Compliance with Standards.....	73

Chapter 1: Safety Information

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

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

Safety margins must be considered in order to avoid activating the under- or over-voltage protection against line variations and/or voltage drop under load. The transformer should be able to deliver the required power to the drive (including peak power) without significant voltage drops (10% maximum). While driving high-inertia loads, the power supply circuit must be equipped with a shunt regulator; otherwise, the drive will be disabled whenever the capacitors are charged above the maximum voltage.

- Before switching on the Falcon, 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 Falcon 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 Falcon 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 Falcon 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 Falcon 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 Falcon 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 Falcon servo drive and the steps for its wiring, installation and powering up. Following these guidelines ensures maximum functionality of the drive and the system to which it is connected.

2.1. *ExtrIQ* Product Family

Elmo Motion Control's *ExtrIQ* product family is a set of durable motion control products for applications operating under extreme environmental conditions. The products are capable of withstanding the following extreme conditions:

Feature	Operation Conditions	Range
Ambient Temperature Range	Non-operating conditions	-50 °C to +100 °C (-58 °F to 212 °F)
	Operating conditions	-40 °C to +71 °C (-40 °F to 160 °F)
Temperature Shock	Non-operating conditions	-40 °C to +71 °C (-40 °F to 160 °F) within 3 min
Altitude	Non-operating conditions	Unlimited
	Operating conditions	-400 m to 12,000 m (-1312 to 39370 feet)
Humidity	Non-operating conditions	Up to 95% non-condensing humidity at 35 °C (95 °F)
	Operating conditions	Up to 95% non-condensing humidity at 25 °C (77 °F), up to 90% non-condensing humidity at 42 °C (108 °F)
Vibration	Operating conditions	20 Hz to 2000 Hz, 14.6 g
Mechanical Shock	Non-operating conditions	±40 g; Half sine, 11 msec
	Operating conditions	±20 g; Half sine, 11 msec

ExtriQ products have a high power density in the range from 50 W to 18,000 W and a current carrying capacity of up to 140 A (280 A peak).

All **ExtriQ** servo drives have been tested using methods and procedures specified in a variety of extended environmental conditions (EEC) standards.

Based on Elmo Motion Control's innovative **ExtriQ** core technology, they support a wide range of motor feedback options, programming capabilities and communication protocols.

2.2. Drive Description

The Falcon is a series of highly durable and intelligent servo drives. Designed for OEMs, the Falcon is part of the Elmo's **ExtriQ** product line designed to endure extended environmental operating conditions.

The digital drives are based on Elmo's advanced **ExtriQ** motion control technology. They operate from a DC power source in current, velocity, position and advanced position modes, in conjunction with a permanent-magnet synchronous brushless motor, DC brush motor, linear motor or voice coil. They are designed for use with any type of sinusoidal and trapezoidal commutation, with vector control. The Falcon can operate as a stand-alone device or as part of a multi-axis system in a distributed configuration on a real-time network.

The Falcon 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 Falcon is provided by a 10 to 195 VDC source. A smart control-supply algorithm enables the Falcon 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.

2.3. Product Features

2.3.1. 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

2.3.2. 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

2.3.3. 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
- 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)

2.3.4. Communication Options

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

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

2.3.5. Feedback Options

- Incremental Encoder – up to 20 Megacounts (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 V to 5 V voltage range
 - Resistance: 100 Ω to 1000 Ω
- Elmo drives provide supply voltage for all the feedback options.

2.3.6. Fault Protection

The Falcon 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

2.4. System Architecture

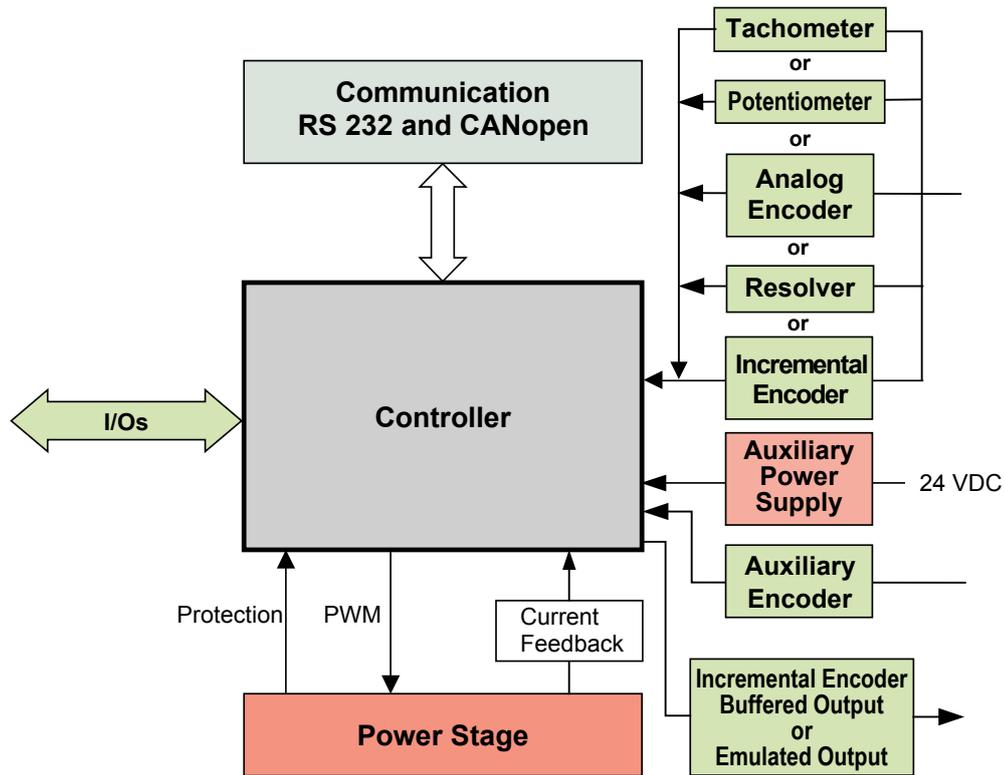


Figure 1: Falcon System Block Diagram

2.5. How to Use this Guide

In order to install and operate your Elmo Falcon 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 Falcon.

[Chapter 4, Technical Specifications](#), lists all the drive ratings and specifications.

Upon completing the instructions in this guide, your Falcon 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.

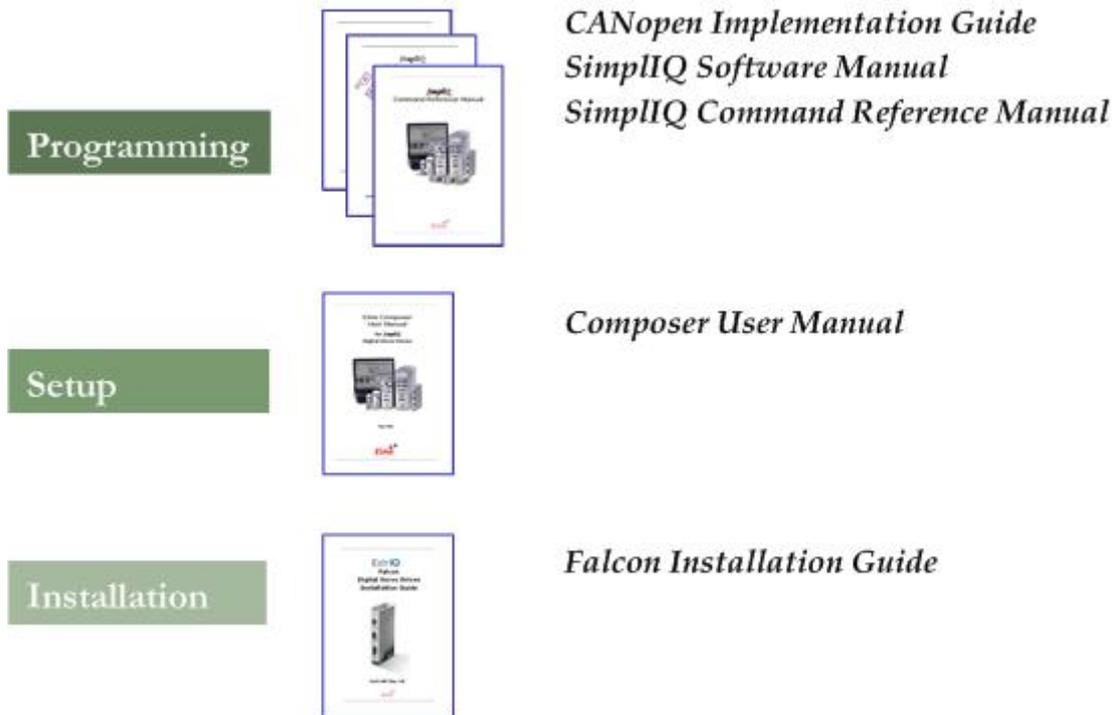


Figure 2: Elmo Documentation Hierarchy

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

Chapter 3: Installation

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

3.1. Before You Begin

3.1.1. Site Requirements

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

Feature	Value
Ambient operating temperature	-40 °C to +70 °C (-40 °F to 160 °F)
Maximum operating altitude	12,000 m (39370 feet)
Maximum non-condensing humidity	95%
Operating area atmosphere	No flammable gases or vapors permitted in area
Models for extended environmental conditions are available.	

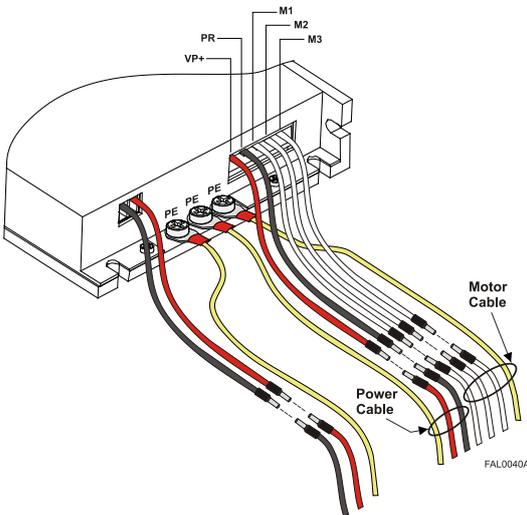


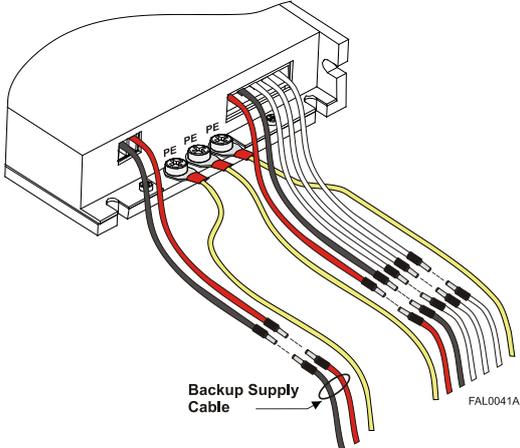
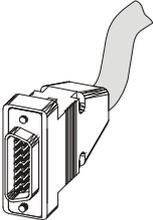
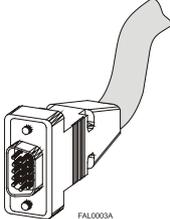
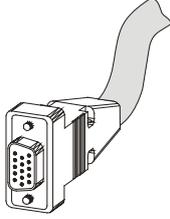
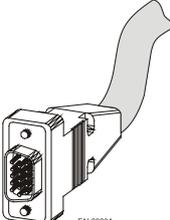
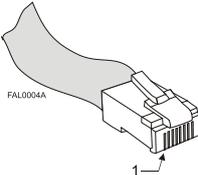
Caution:

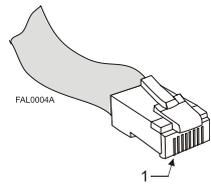
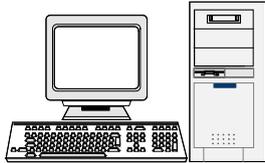
The Falcon dissipates its heat by natural convection. The maximum ambient operating temperature of -40 °C to +70 °C (-40 °F to 160 °F) must not be exceeded.

3.1.2. Hardware Requirements

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

Component	Wire	Described in Section	Drawing
Main Power Cable	VP+ - red PR- black	3.4.2.2	
Motor Cable	M1 M2 M3- white	3.4.2.1	

Component	Wire	Described in Section	Drawing
Backup Supply Cable (if needed)	24 V-red/black	3.4.3	
Main Feedback Cable	FEEDBACK A	3.4.5	
Auxiliary Feedback Cable (if needed)	FEEDBACK B	3.4.7	
Digital I/O Cable (if needed)	GENERAL I/O J1	3.4.8.1	
Digital Inputs and Analog Inputs Cable (if needed)	GENERAL I/O J2	3.4.8.2	
RS232 Communication Cable	RS-232	3.4.9.1	

Component	Wire	Described in Section	Drawing
CAN Communication cable(s) (if needed)	CAN (in) CAN (out)	3.4.9.2	
PC for drive setup and tuning			
Motor data sheet or manual			

3.2. Unpacking the Drive Components

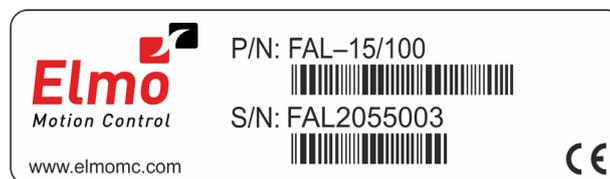
Before you begin working with the Falcon system, verify that you have all of its components, as follows:

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

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

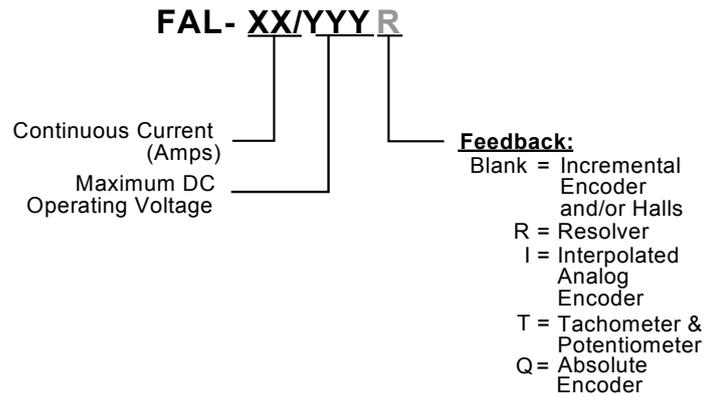
To unpack the Falcon:

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



FAL006B

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



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

3.3. Mounting the Falcon

The Falcon 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 Falcon (see the diagram below).

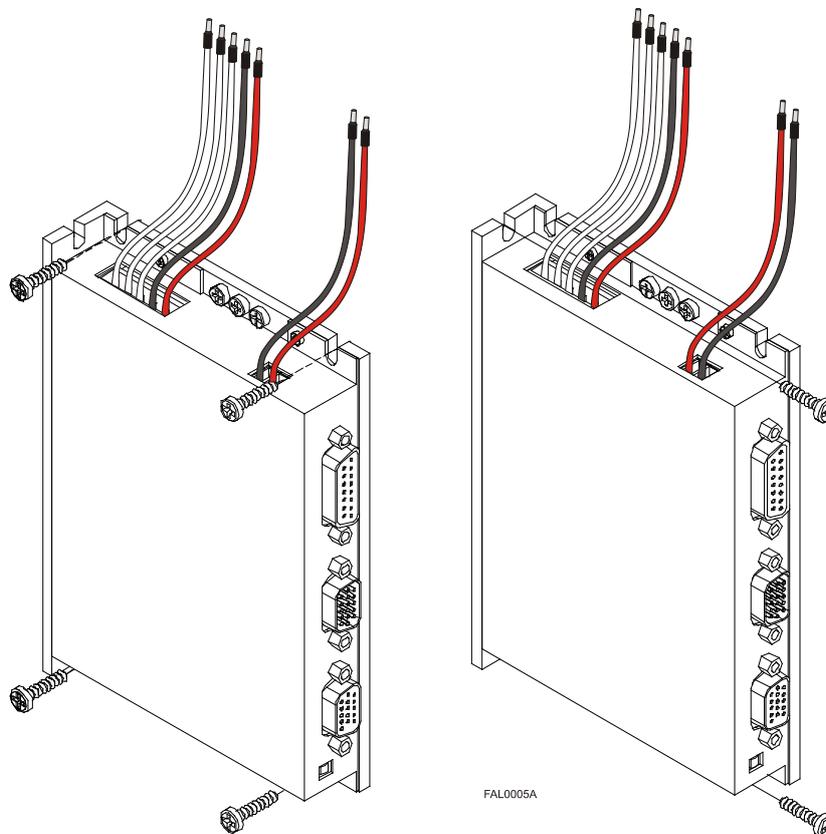


Figure 3: Mounting the Falcon

3.4. Connecting the Cables

The Falcon has ten connectors.

3.4.1. Wiring the Falcon

Once the Falcon 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 Falcon.



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: $C < 30 \text{ nF}$ 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 Falcon.

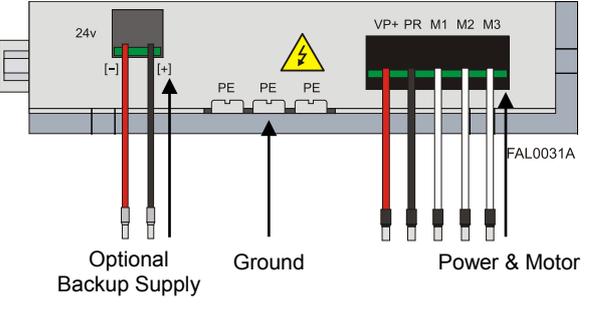
Type	Function	Port	Connector Location
5-Pin Phoenix (first 2 pins) (provided)	Power	VP+, PR	
5-Pin Phoenix (last 3 pins) (provided)	Motor	M1, M2, M3	
3 ground screws	Ground	PE, PE, PE	
2-Pin Phoenix (provided)	Optional Backup Supply	24 VDC	

Table 1: Connectors on the “Bottom” of the Falcon

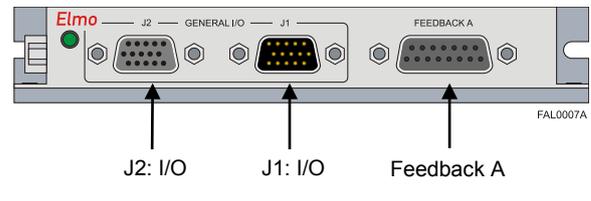
Type	Function	Port	Connector Location
15-Pin D-Sub	Feedback A	Feedback A	
15-Pin D-Sub (high-density)	General I/O	J1	
15-Pin D-Sub (high-density)	General I/O	J2	

Table 2: Connectors on the “Front” of the Falcon

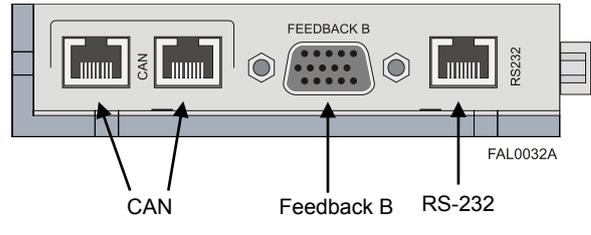
Type	Function	Port	Connector Location
8-Pin RJ-45	CAN	CAN	
8-Pin RJ-45	CAN	CAN	
15-Pin D-Sub (high-density)	Feedback B	Feedback B	
8-Pin RJ-45	RS-232	RS-232	

Table 3: Connectors on the “Top” of the Falcon

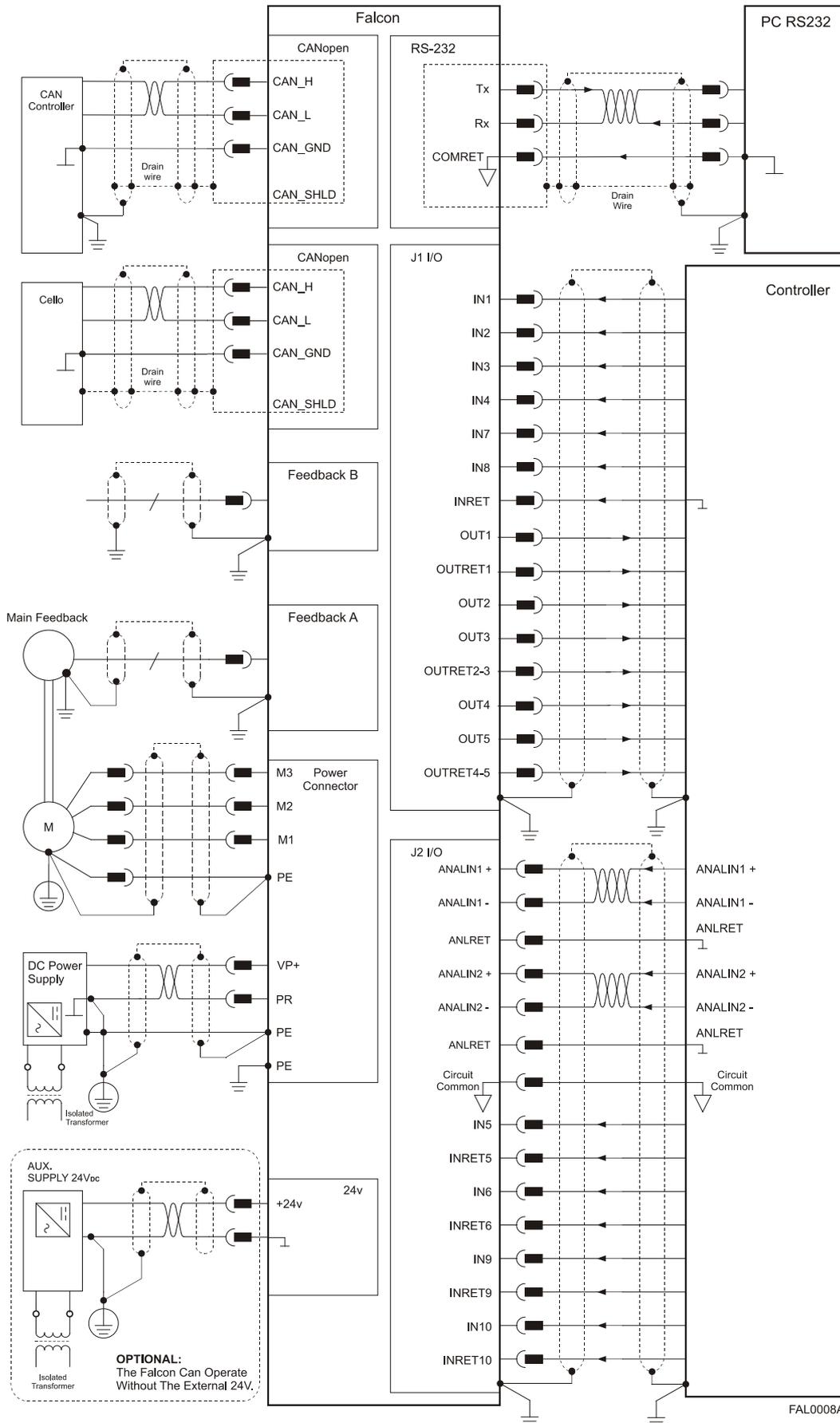
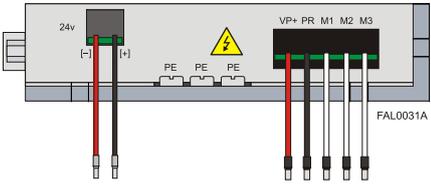
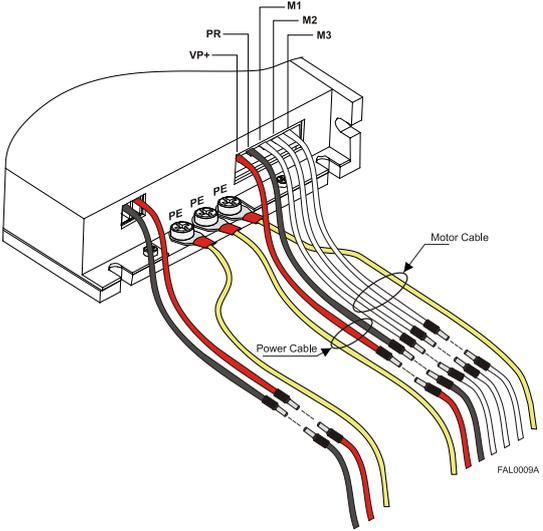


Figure 4: Falcon Detailed Connection Diagram

3.4.2. Connecting the Power Cables

The main power connector located at the bottom of the Falcon, as follows:

Pin	Function	Cable		Pin Positions
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	

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

Table 4: Connector for Main Power and Motor Cables

3.4.2.1. 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 Falcon.
- Be sure that the motor chassis is properly grounded.

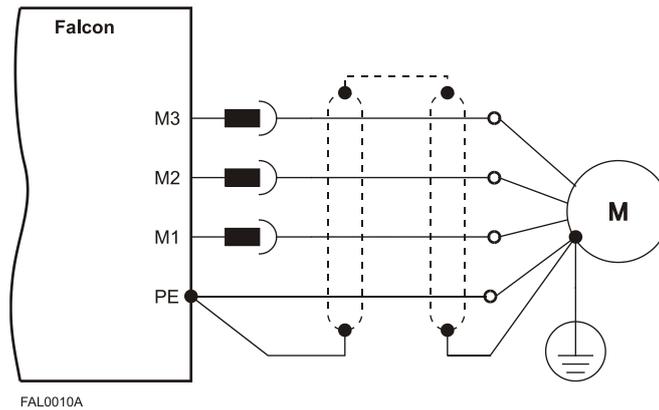


Figure 5: AC Motor Power Connection Diagram

3.4.2.2. 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 Falcon’s heatsink.

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 Falcon’s heatsink.
- For safety reasons connect the PR of the power supply to the closest ground connection.

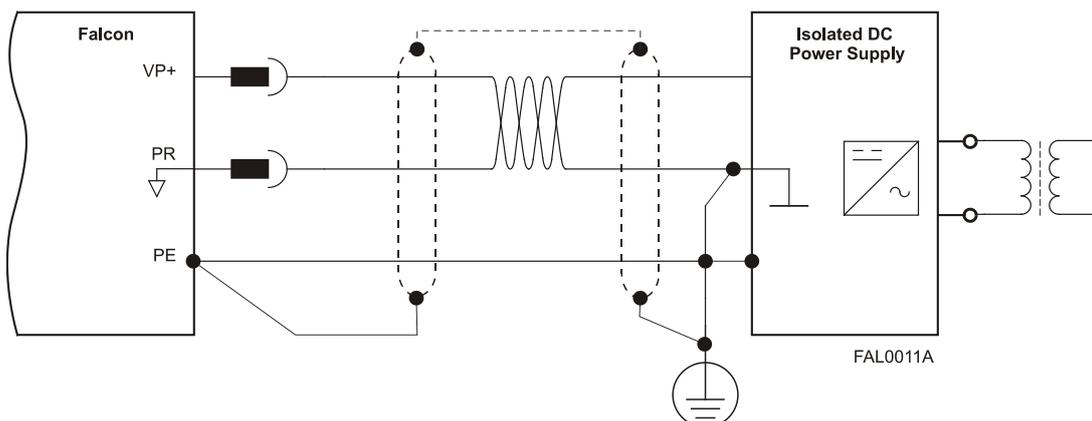


Figure 6: Main Power Supply Connection Diagram

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

Power to the Falcon is provided by a 10 to 195 VDC source. A “smart” control-supply algorithm enables the Falcon 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 (13 V_{min} to 40 V_{max}) 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 Falcon, use the 2-pin power plug provided with the Falcon. *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.

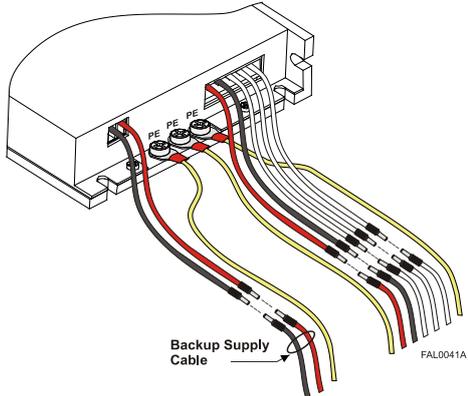
Pin	Signal	Function	Pin Positions
[+]	+24VDC	+24 VDC backup supply	
[-]	RET24VDC	Return (common) of the 24 VDC backup supply	

Table 5: Backup Cable Plug

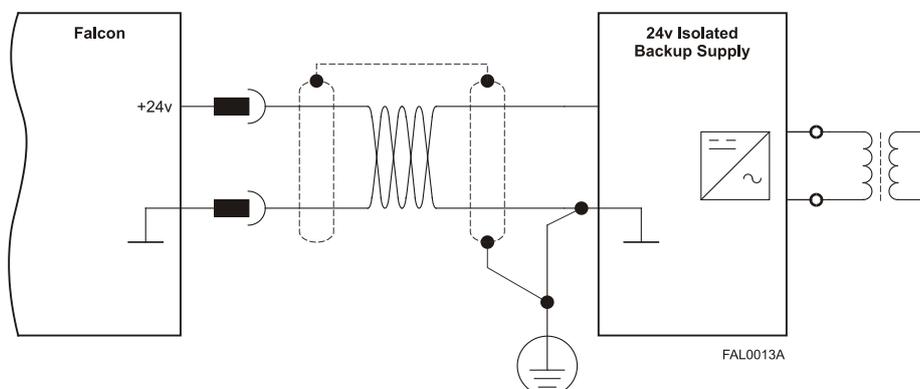


Figure 7: Backup Supply (24 V) Connection Diagram

“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 (13 V min to 40 V max) supply for backing up the control parameters if DC power is shut off.

3.4.4. Feedback and Control Cable Assemblies

The Falcon 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.
2. Use only a D-Sub connector with a **metal housing**.
3. 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.
4. On the motor side connections, ground the shield to the motor chassis.
5. On controller side connections, follow the controller manufacturer’s recommendations concerning the shield.

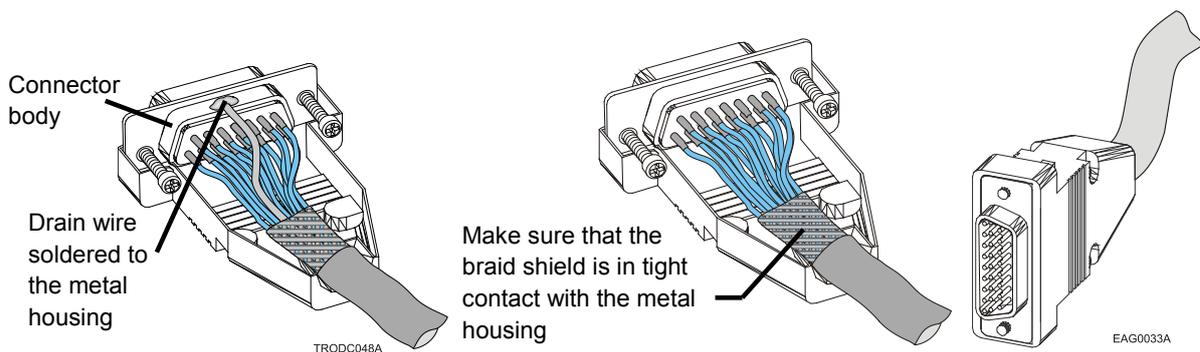


Figure 8: Feedback and Control Cable Assemblies

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

3.4.5. Main Feedback Cable (FEEDBACK A)

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

The Falcon 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

FEEDBACK A on the “front” of the Falcon 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 3.4.4 (Feedback and Control Cable Assemblies).

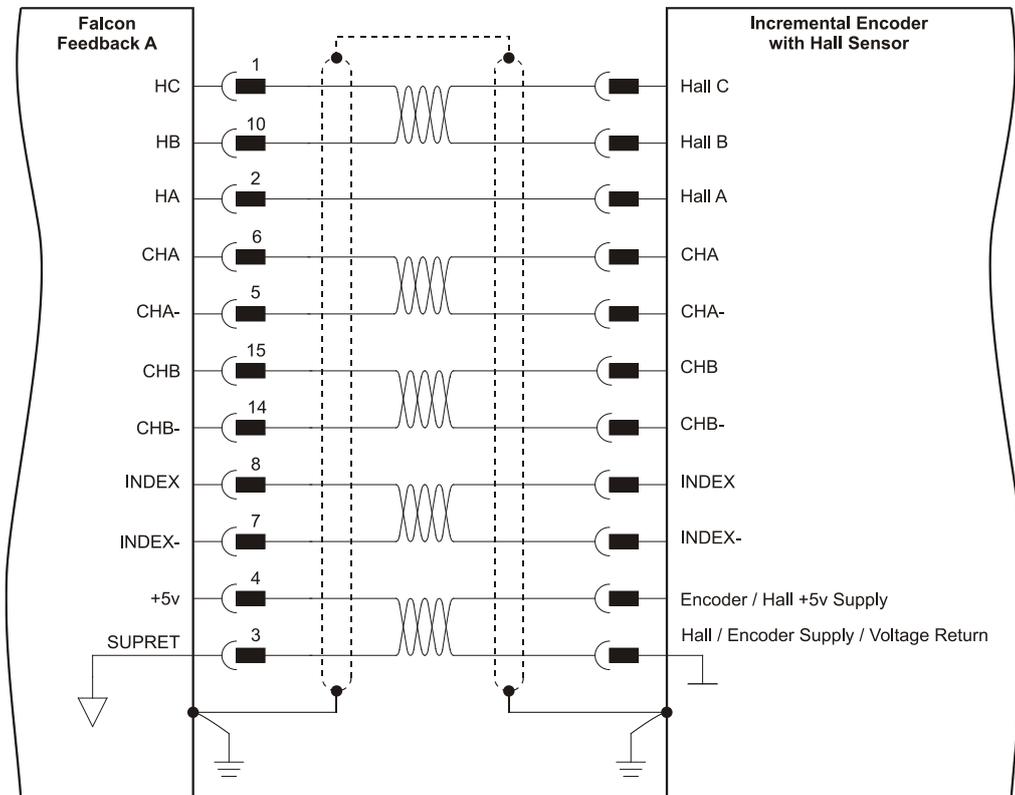
Incremental Encoder			Interpolated Analog Encoder		Resolver		Tachometer and Potentiometer	
FAL-XX/YYY_			FAL-XX/YYYYI		FAL-XX/YYYYR		FAL-XX/YYYYT	
Pin	Signal	Function	Signal	Function	Signal	Function	Signal	Function
1	HC	Hall sensor C input	HC	Hall sensor C input	NC	-	HC	Hall sensor C input
2	HA	Hall 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			
FAL-XX/YYYYQ			
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)



FAL0014A

Figure 9: Main Feedback – Incremental Encoder Connection Diagram

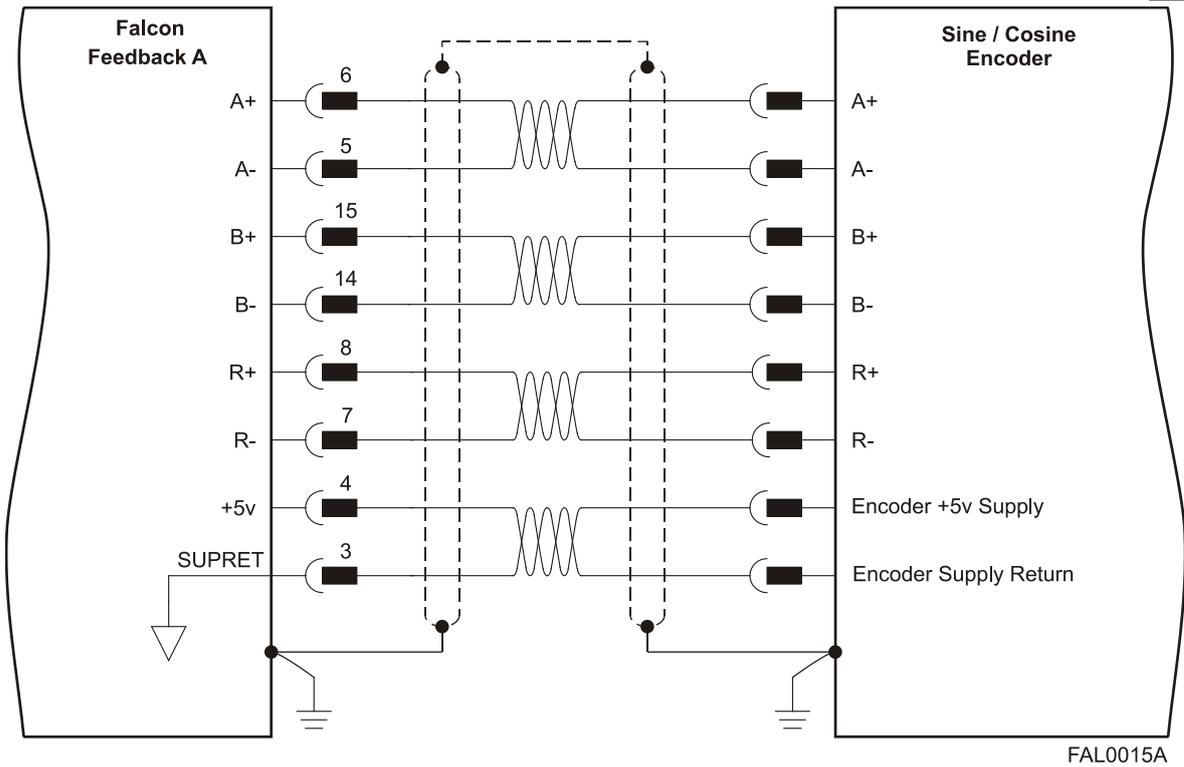


Figure 10: Main Feedback – Interpolated Analog (Sine/Cosine) Encoder Connection Diagram

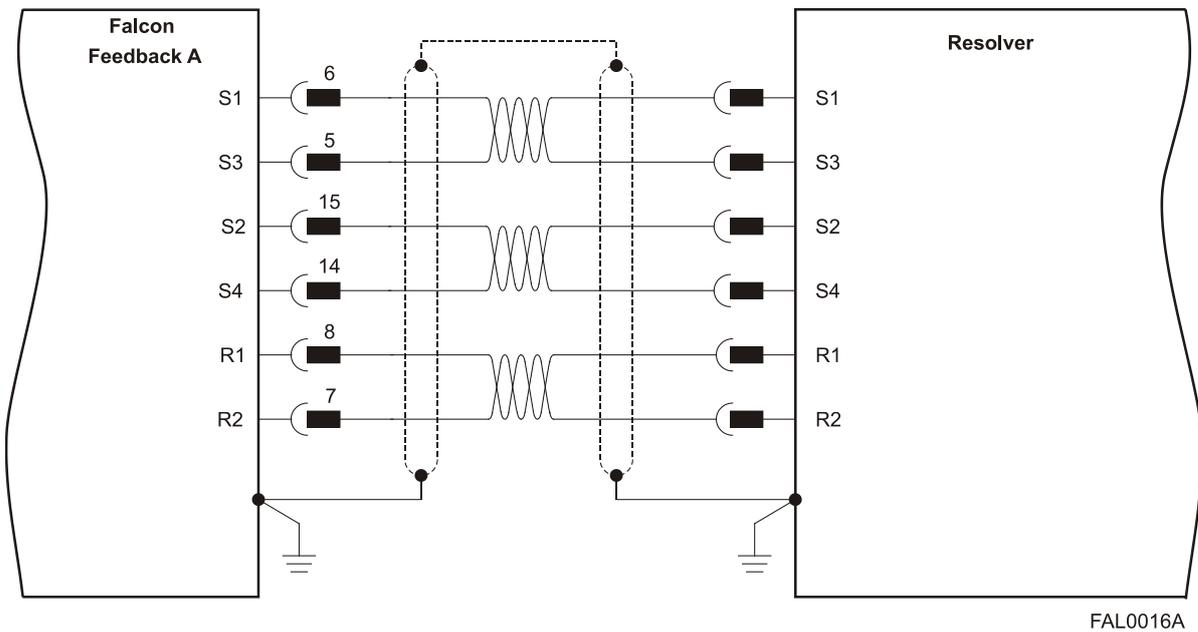


Figure 11: Main Feedback – Resolver Connection Diagram

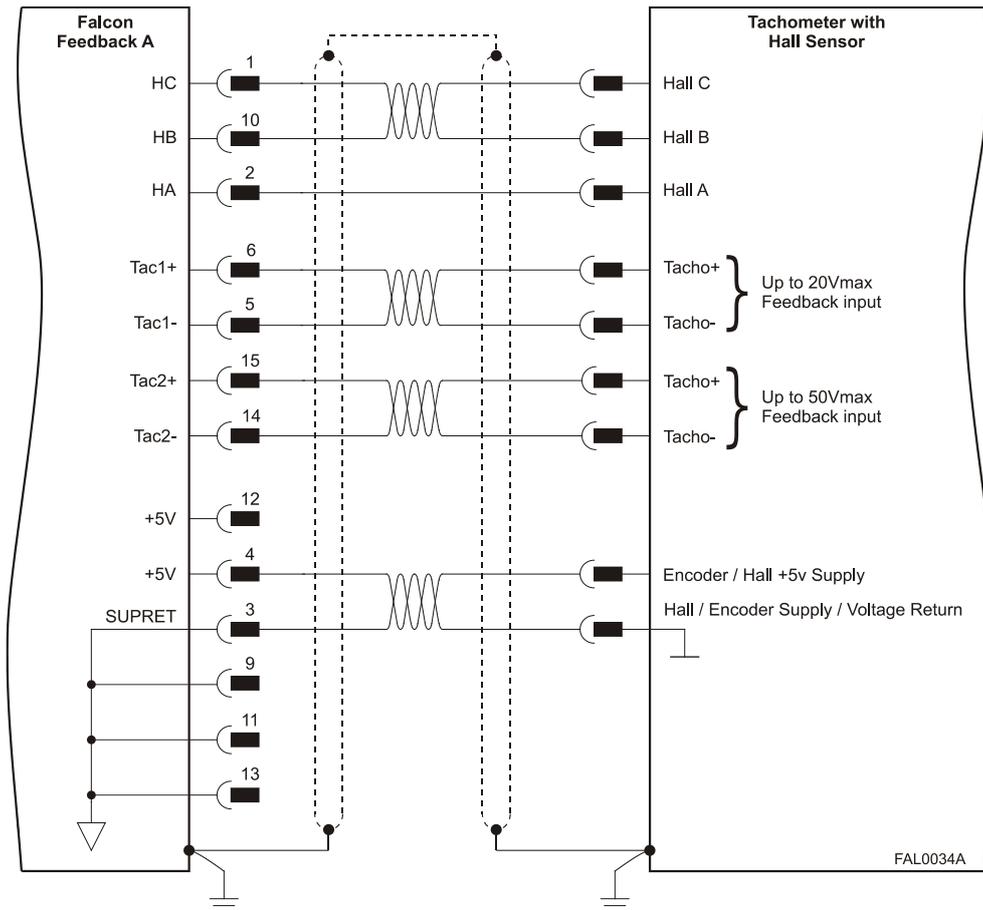


Figure 12: Main Feedback – Tachometer Feedback with Digital Hall Sensor Connection Diagram for Brushless Motors

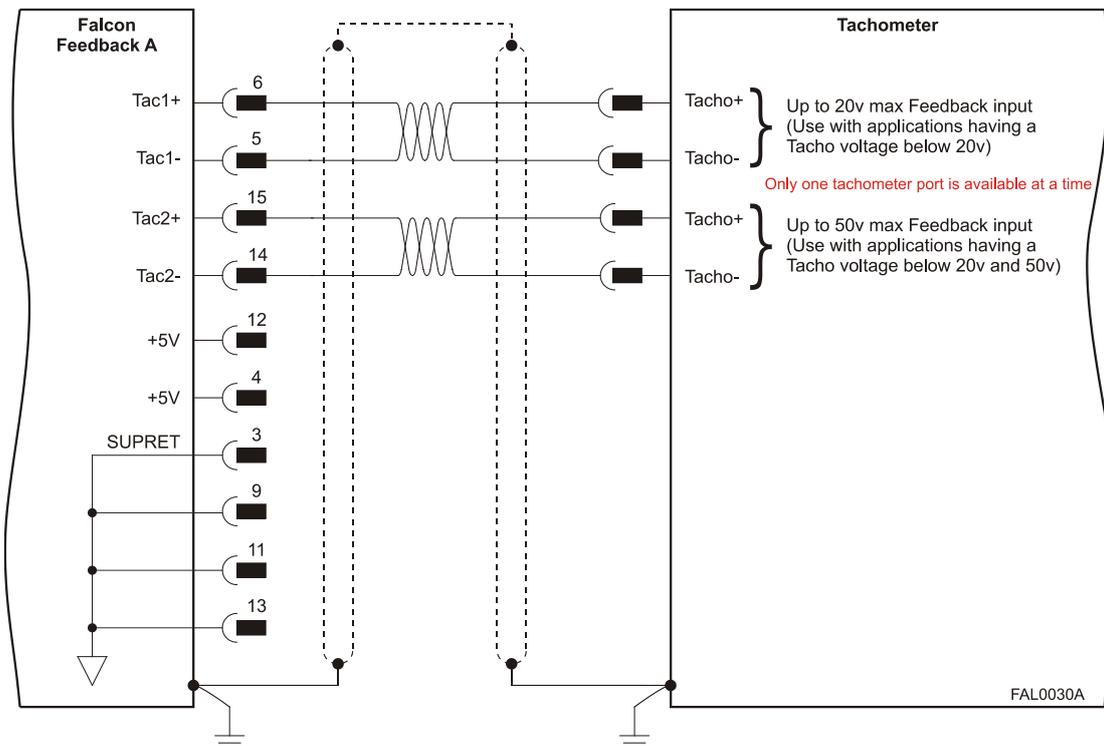


Figure 13: Main Feedback – Tachometer Feedback Connection Diagram for Brush Motors

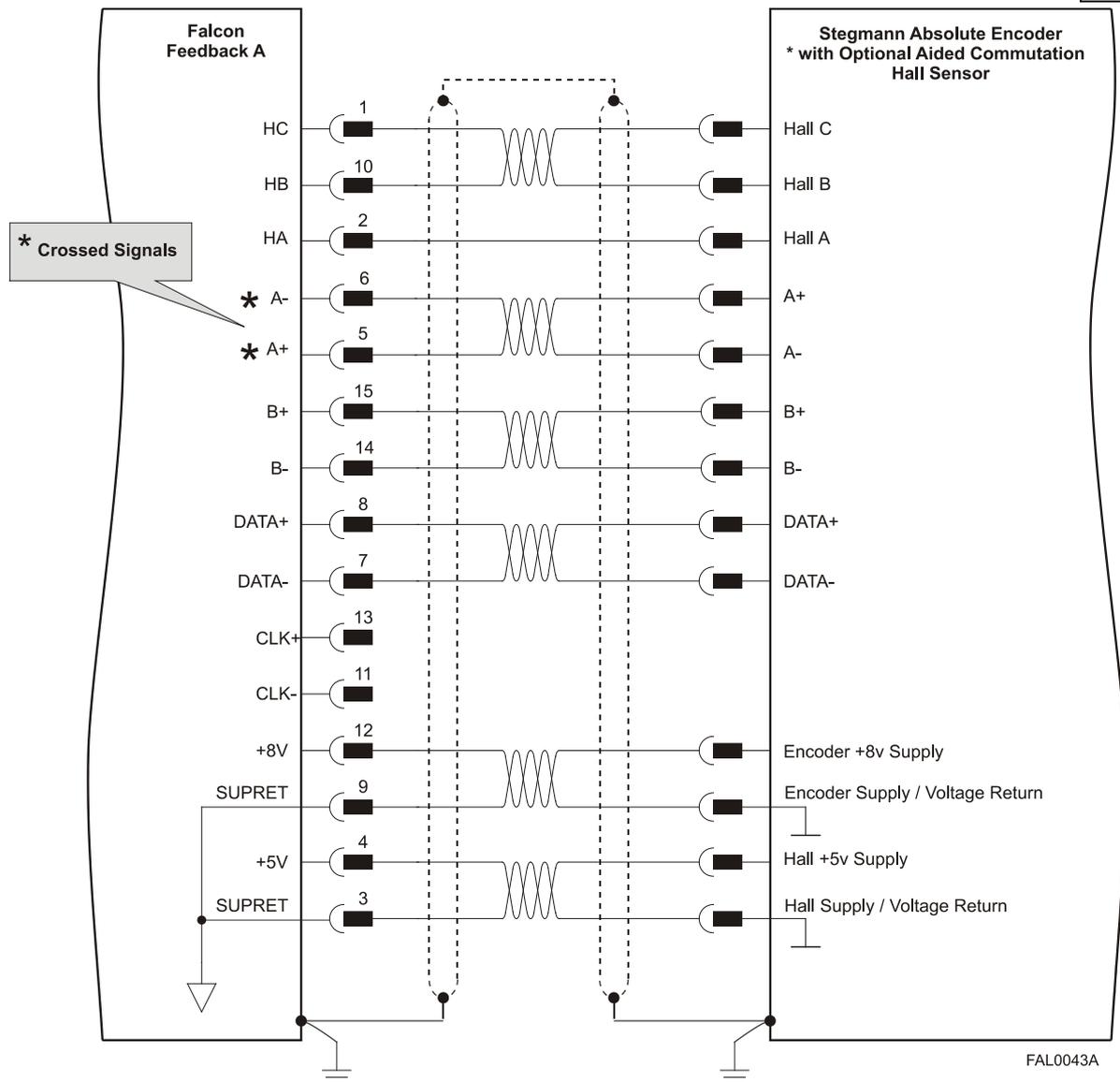


Figure 16: Main Feedback – Stegmann Feedback Connection Diagram

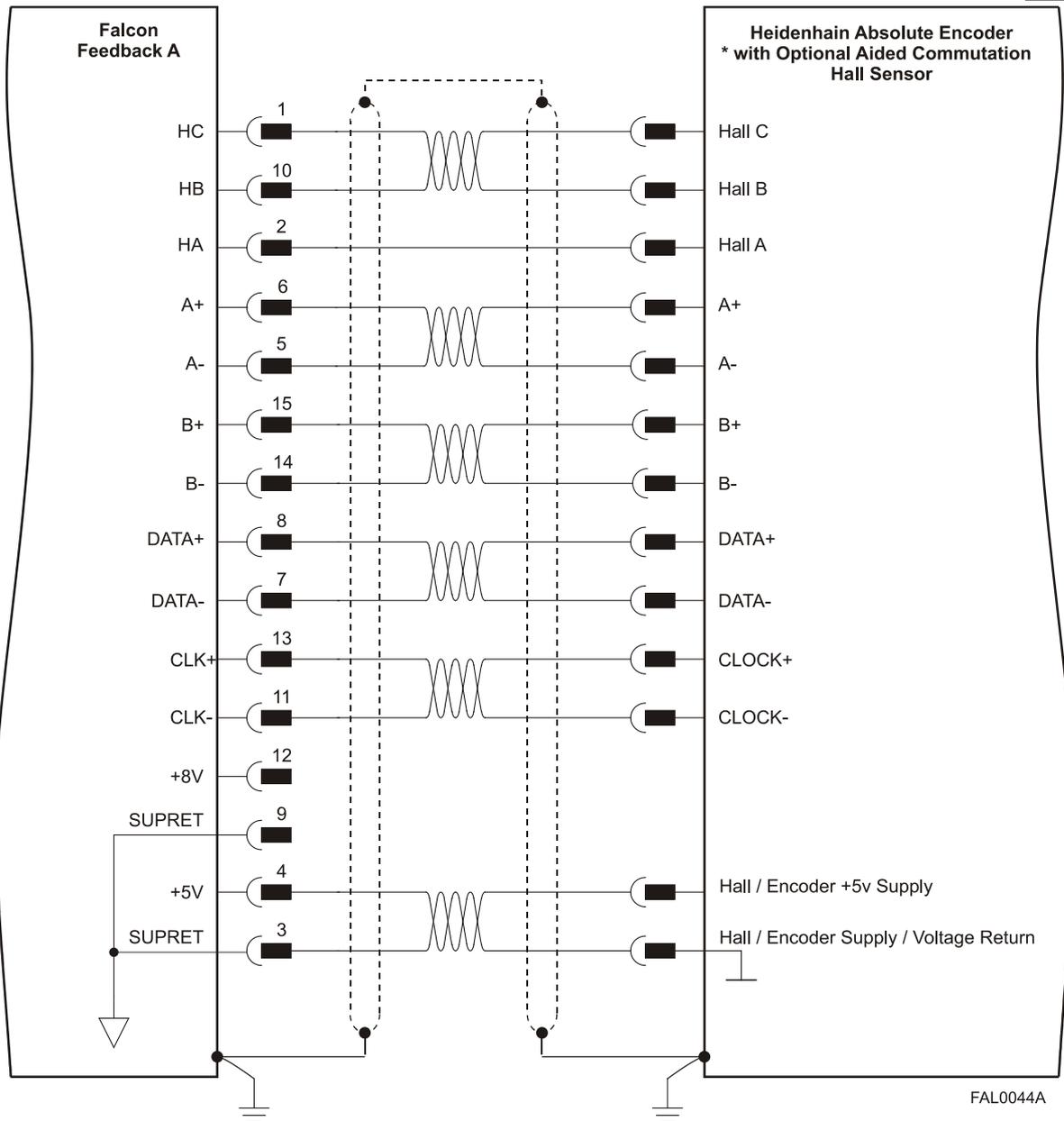
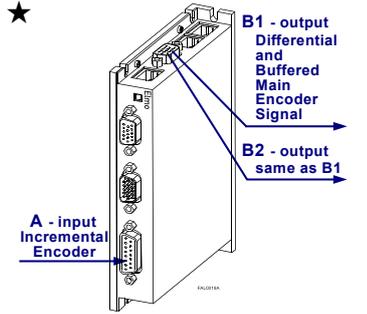
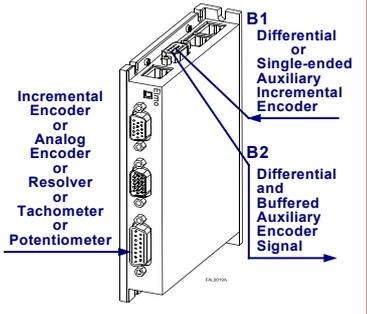
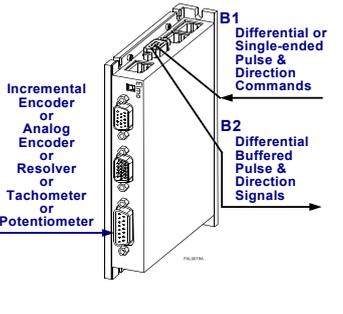
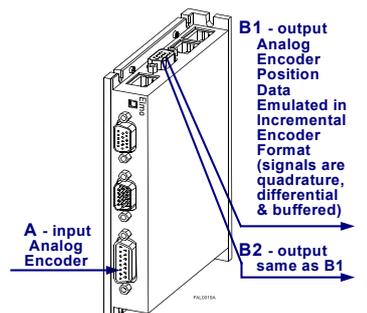
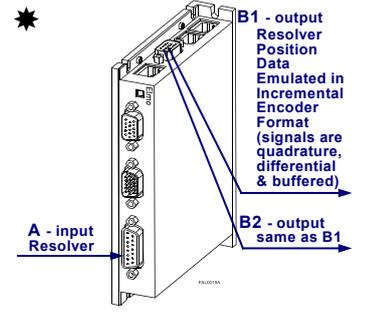
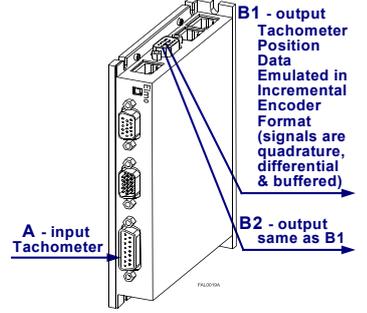


Figure 17: Main Feedback – Heidenhain Feedback Connection Diagram

3.4.6. 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 Falcon, "FEEDBACK B" has two ports, Port B1 and Port B2. 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 ★	 <p>B1 - output Differential and Buffered Main Encoder Signal</p> <p>B2 - output same as B1</p> <p>A - input Incremental Encoder</p>	 <p>B1 Differential or Single-ended Auxiliary Incremental Encoder</p> <p>B2 Differential and Buffered Auxiliary Encoder Signal</p> <p>Incremental Encoder or Analog Encoder or Resolver or Tachometer or Potentiometer</p>	 <p>B1 Differential or Single-ended Pulse & Direction Commands</p> <p>B2 Differential Buffered Pulse & Direction Signals</p> <p>Incremental Encoder or Analog Encoder or Resolver or Tachometer or Potentiometer</p>
Interpolated Analog (Sine/Cosine) Encoder Input ★	 <p>B1 - output Analog Encoder Position Data Emulated in Incremental Encoder Format (signals are quadrature, differential & buffered)</p> <p>B2 - output same as B1</p> <p>A - input Analog Encoder</p>		
Resolver Input ★	 <p>B1 - output Resolver Position Data Emulated in Incremental Encoder Format (signals are quadrature, differential & buffered)</p> <p>B2 - output same as B1</p> <p>A - input Resolver</p>		
Tachometer Input	 <p>B1 - output Tachometer Position Data Emulated in Incremental Encoder Format (signals are quadrature, differential & buffered)</p> <p>B2 - output same as B1</p> <p>A - input Tachometer</p>		

FEEDBACK A		FEEDBACK B Ports B1 and B2		
Software Setting	YA[4] = 4	YA[4] = 2	YA[4] = 0	
Potentiometer Input				
Typical Applications	<ul style="list-style-type: none"> ★ 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. 	<p>Any application where two feedbacks are used by the drive.</p> <p>Port B1 serves as an input for the auxiliary incremental encoder (differential or single-ended).</p> <p>Port B2 is used to output differential buffered Auxiliary Incremental Encoder signals.</p> <p>For applications such as Follower, ECAM, or Dual Loop.</p>	<p>Port B1 serves as an input for Pulse & Direction commands (differential or single-ended).</p> <p>Port B2 is used to output differential buffered Pulse & Direction signals.</p>	

3.4.7. 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.

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

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

- The Falcon is used as a current amplifier to provide position data to the position controller.
- The Falcon is used in velocity mode, to provide position data to the position controller.
- The Falcon 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):

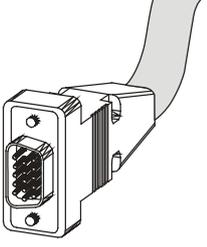
Port	Pin	Signal	Function	Pin Positions
B1	1	CHA	Auxiliary channel A high output	 15-Pin High Density D-Sub Plug
B1	2	CHA-	Auxiliary channel A low output	
B1	3	CHB	Auxiliary channel B high output	
B1	4	CHB-	Auxiliary channel B low output	
B1	5	INDEX	Auxiliary Index high output	
B2	6	CHAO	Buffered channel A output	
B2	7	CHAO-	Buffered channel A complement output	
PWR	8	+5V	Encoder supply voltage	 15-Pin High Density D-Sub Socket
PWR	9	SUPRET	Encoder supply voltage return	
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 Falcon 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 3.4.4 (Feedback and Control Cable Assemblies).

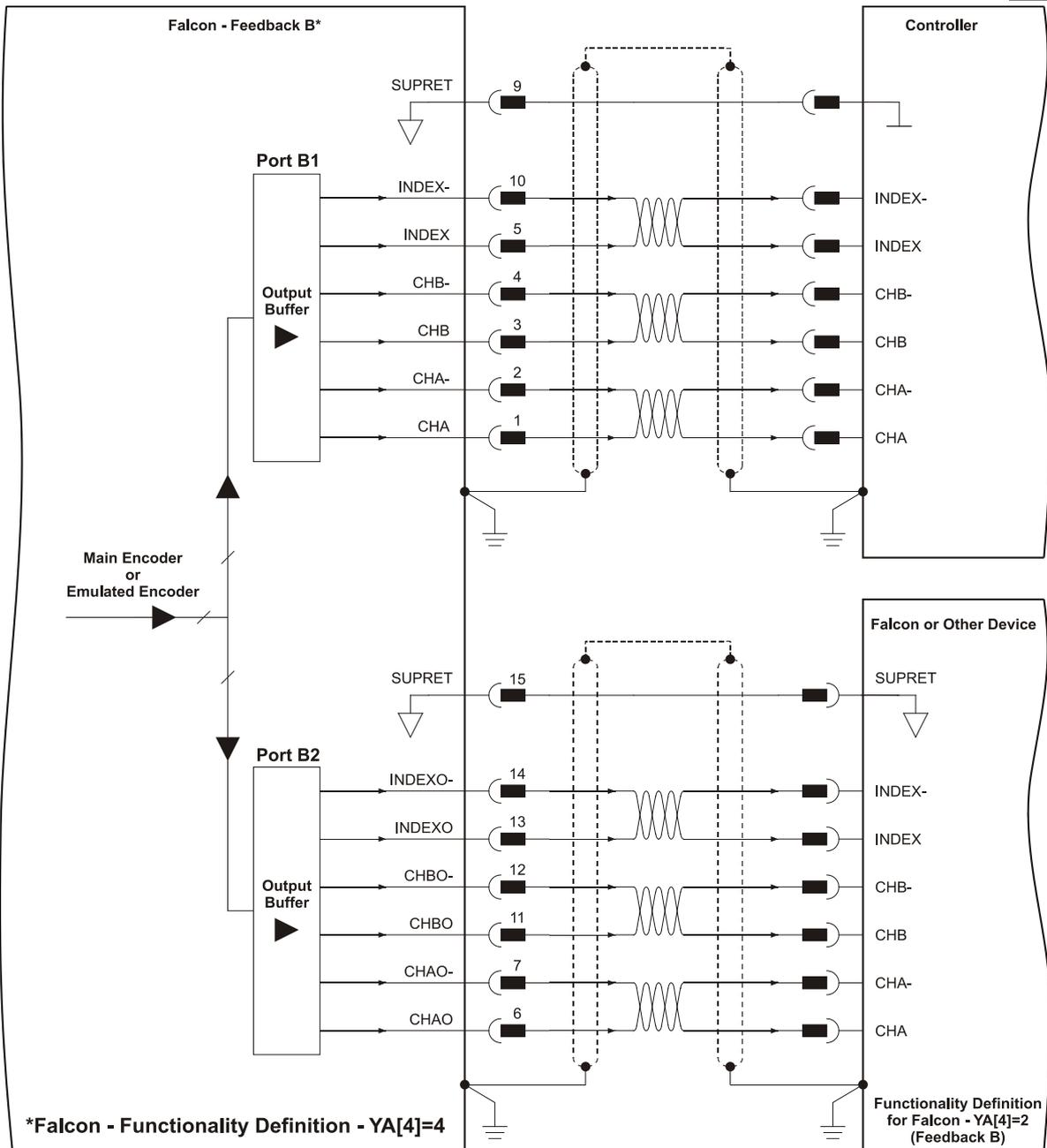


Figure 18: Main Encoder Buffered Output or Emulated Encoder Output on FEEDBACK B - Connection Diagram

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

The Falcon 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:

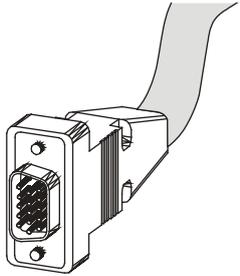
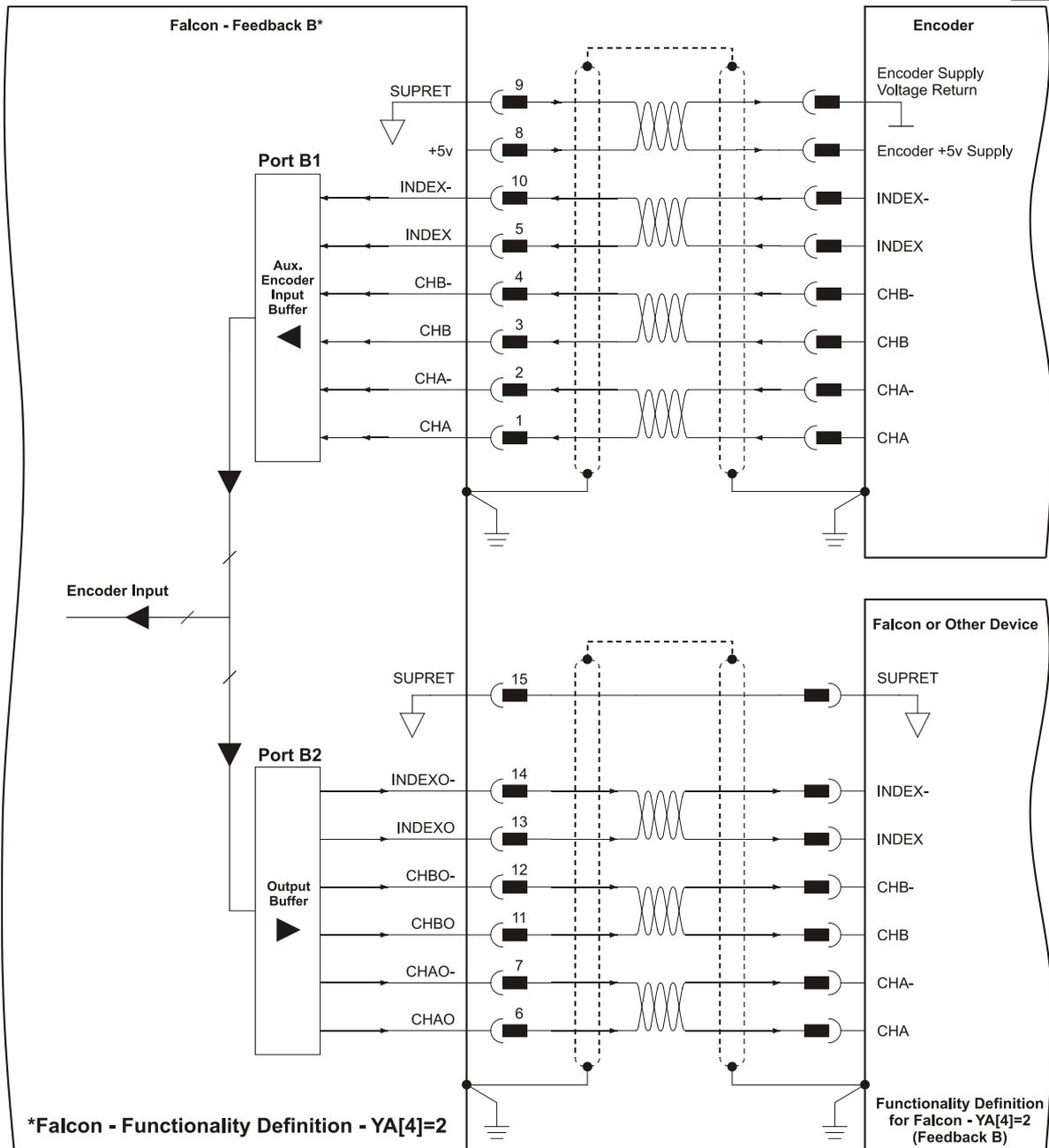
Port	Pin	Signal	Function	Pin Positions
B1	1	CHA	Auxiliary channel A high <i>input</i>	 <p>15-Pin High Density D-Sub Plug</p>
B1	2	CHA-	Auxiliary channel A low <i>input</i>	
B1	3	CHB	Auxiliary channel B high <i>input</i>	
B1	4	CHB-	Auxiliary channel B low <i>input</i>	
B1	5	INDEX	Auxiliary Index high <i>input</i>	
B2	6	CHAO	Buffered channel A output	
B2	7	CHAO-	Buffered channel A complement output	
PWR	8	+5V	Encoder supply voltage	 <p>15-Pin High Density D-Sub Socket</p>
PWR	9	SUPRET	Encoder supply voltage return	
B1	10	INDEX-	Auxiliary Index low <i>input</i>	
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 9: Differential Auxiliary Encoder Input Option on FEEDBACK B Pin Assignments

FEEDBACK B on the “top” of the Falcon 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 3.4.4 (Feedback and Control Cable Assemblies).



FAL0021A

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

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

The Falcon 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:

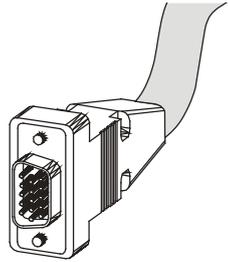
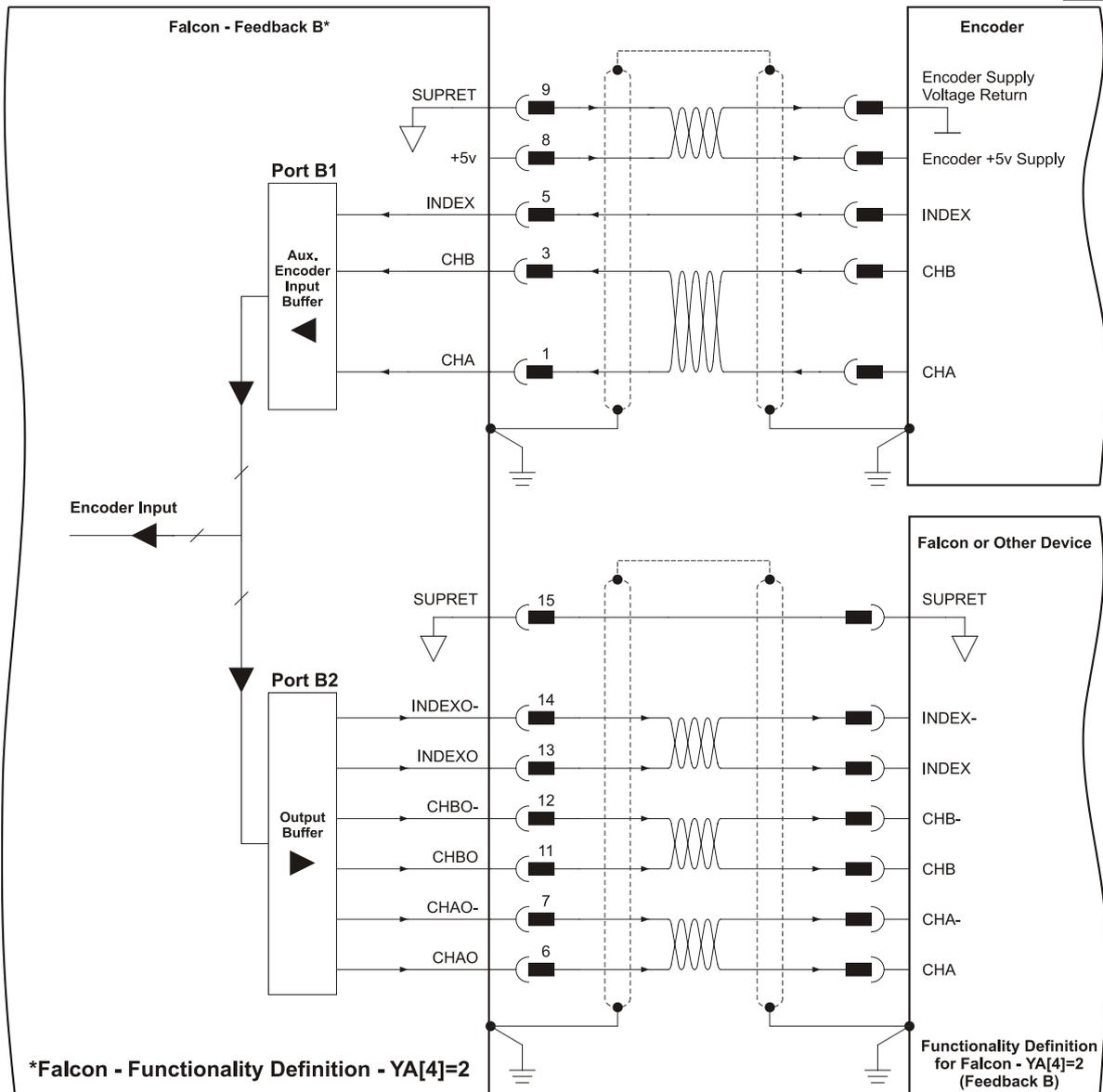
Port	Pin	Signal	Function	Pin Positions
B1	1	CHA	Auxiliary channel A high <i>input</i>	 15-Pin High Density D-Sub Plug
	2	NC	Do not connect this pin	
B1	3	CHB	Auxiliary channel B high <i>input</i>	
	4	NC	Do not connect this pin	
B1	5	INDEX	Auxiliary Index high <i>input</i>	
B2	6	CHAO	Channel A output	
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 Falcon 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 3.4.4 (Feedback and Control Cable Assemblies).



FAL0022A

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

3.4.7.4. 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 set up to run as a single-ended pulse-and-direction input:

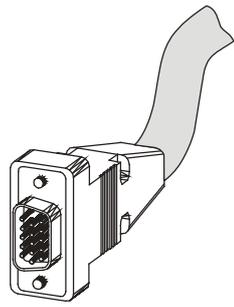
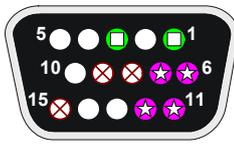
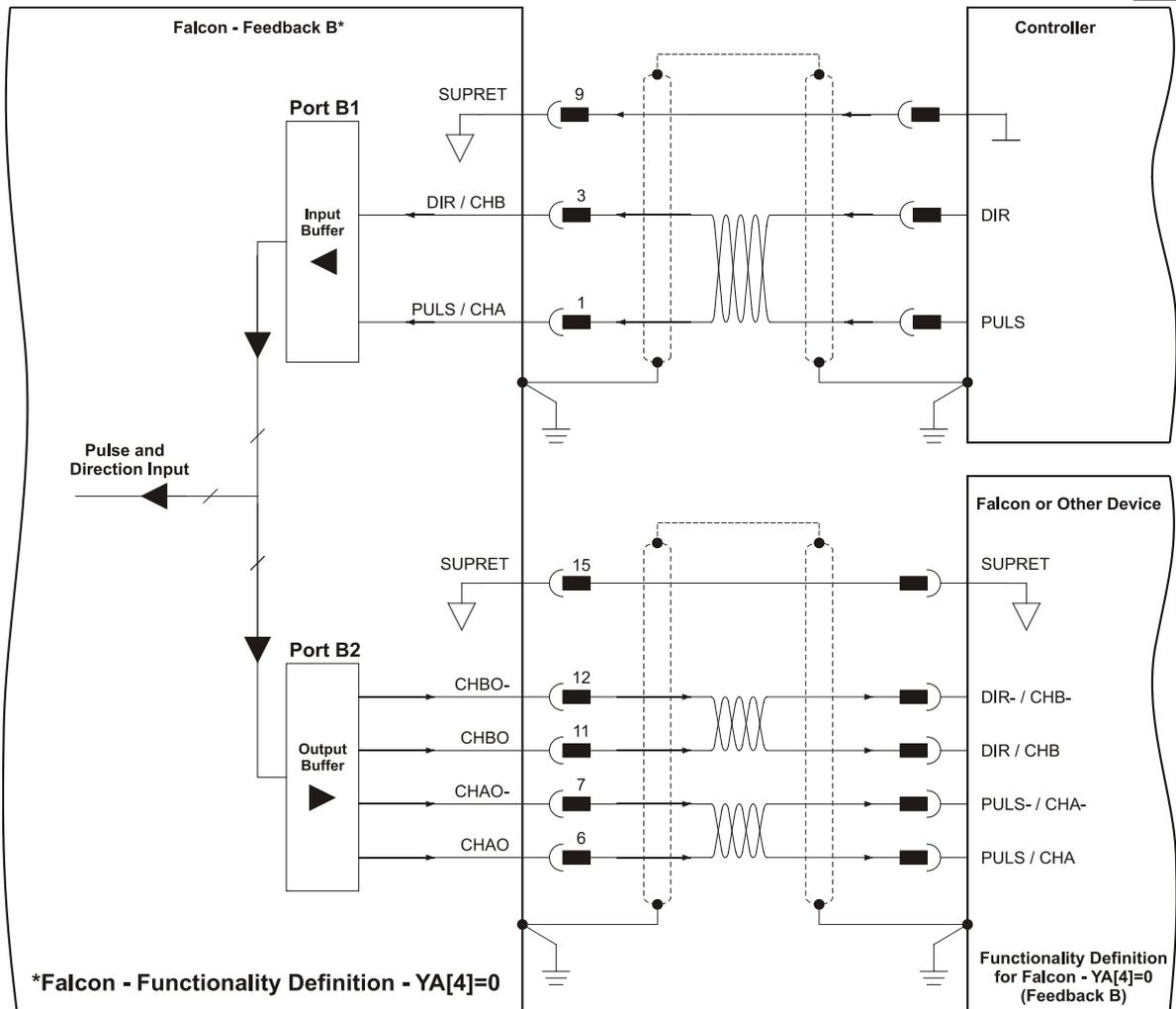
Port	Pin	Signal	Function	Pin Positions
B1	1	PULS/CHA	Pulse/Auxiliary channel A high <i>input</i>	 <p>15-Pin D-Sub Plug</p>
	2	NC	Do not connect this pin	
B1	3	DIR/CHB	Direction/Auxiliary channel B high <i>input</i>	
	4	NC	Do not connect this pin	
	5	NC	Do not connect this pin	
B2	6	CHAO	Channel A output	
B2	7	CHAO-	Channel A complement output	
PWR	8	+5V	Encoder supply voltage	
PWR	9	SUPRET	Encoder supply voltage return	
	10	NC	Do not connect this pin	
B2	11	CHBO	Channel B output.	 <p>15-Pin D-Sub Socket</p>
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 Falcon 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 3.4.4 (Feedback and Control Cable Assemblies).



FAL0023A

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

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

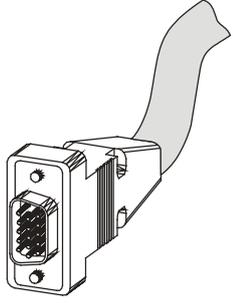
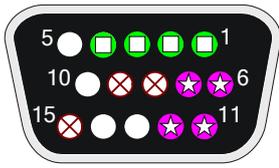
Port	Pin	Signal	Function	Pin Positions
B1	1	PULS/CHA	Pulse/Auxiliary channel A high <i>input</i>	 15 Pin D-Sub Plug
B1	2	PULS-/CHA-	Pulse-/Auxiliary channel A low <i>input</i>	
B1	3	DIR/CHB	Direction/Auxiliary channel B high <i>input</i>	
B1	4	DIR-/CHB-	Direction-/Auxiliary channel B low <i>input</i>	
	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	
	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	 15 Pin D-Sub Socket

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

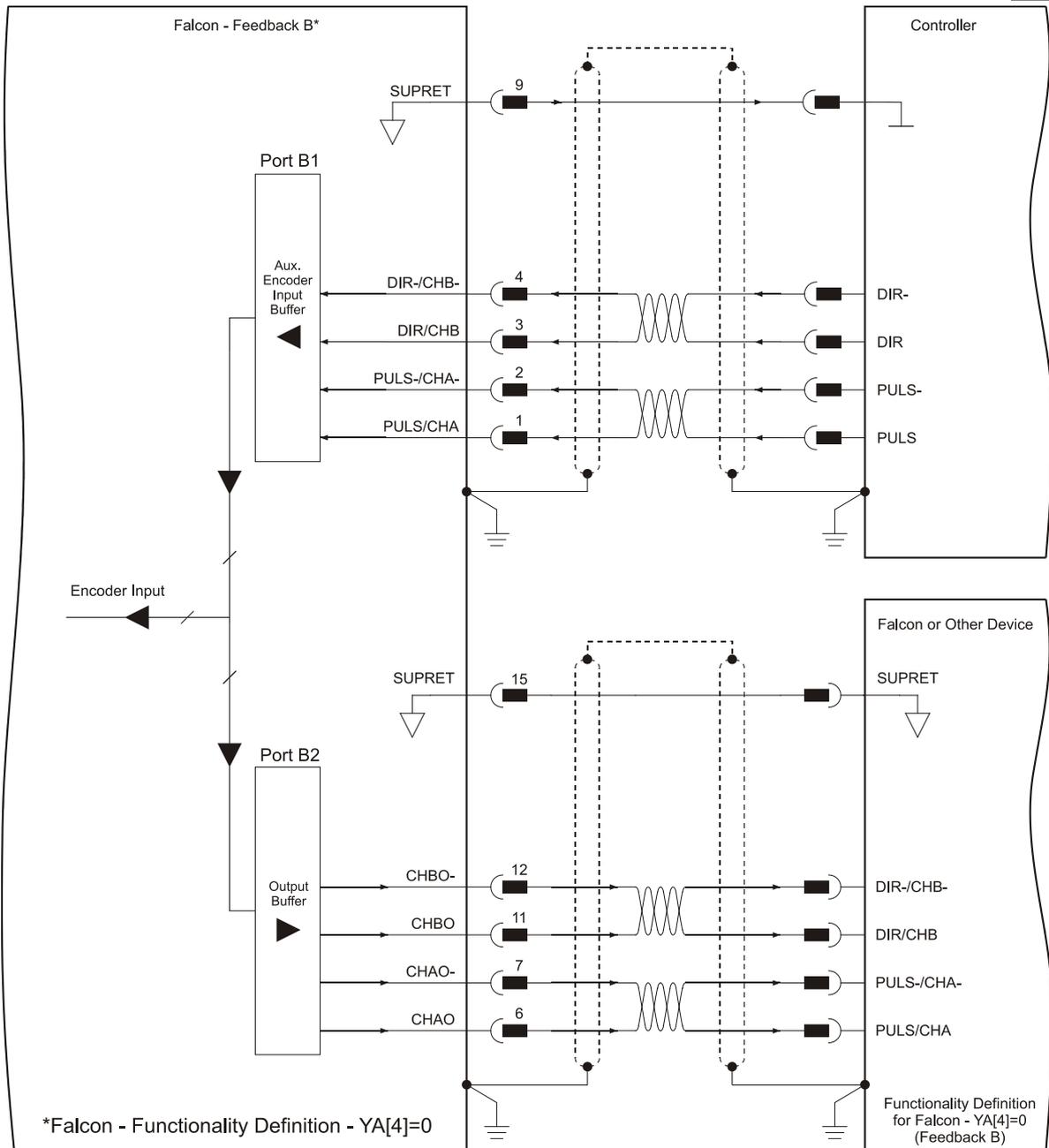


Figure 22: Differential Pulse-and-Direction Input Option on FEEDBACK B – Connection Diagram

3.4.8. I/O Cables

The Falcon 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 (Sine/Cosine) inputs:

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

3.4.8.1. 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 3.4.4 (Feedback and Control Cable Assemblies) using a 15-pin high density metal case D-Sub female connector (socket).

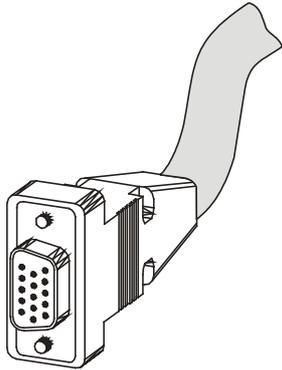
Pin	Signal	Function	Pin Positions
1	IN1	Programmable input 1	
2	IN2	Programmable input 2	
3	IN3	Programmable input 3	
4	OUT2	Programmable output 2	
5	OUT3	Programmable output 3	
6	IN4	Programmable input 4	
7	IN7	Programmable input 7	
8	IN8	Programmable input 8	
9	INRET	General input return	
10	OUTRET2-3	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

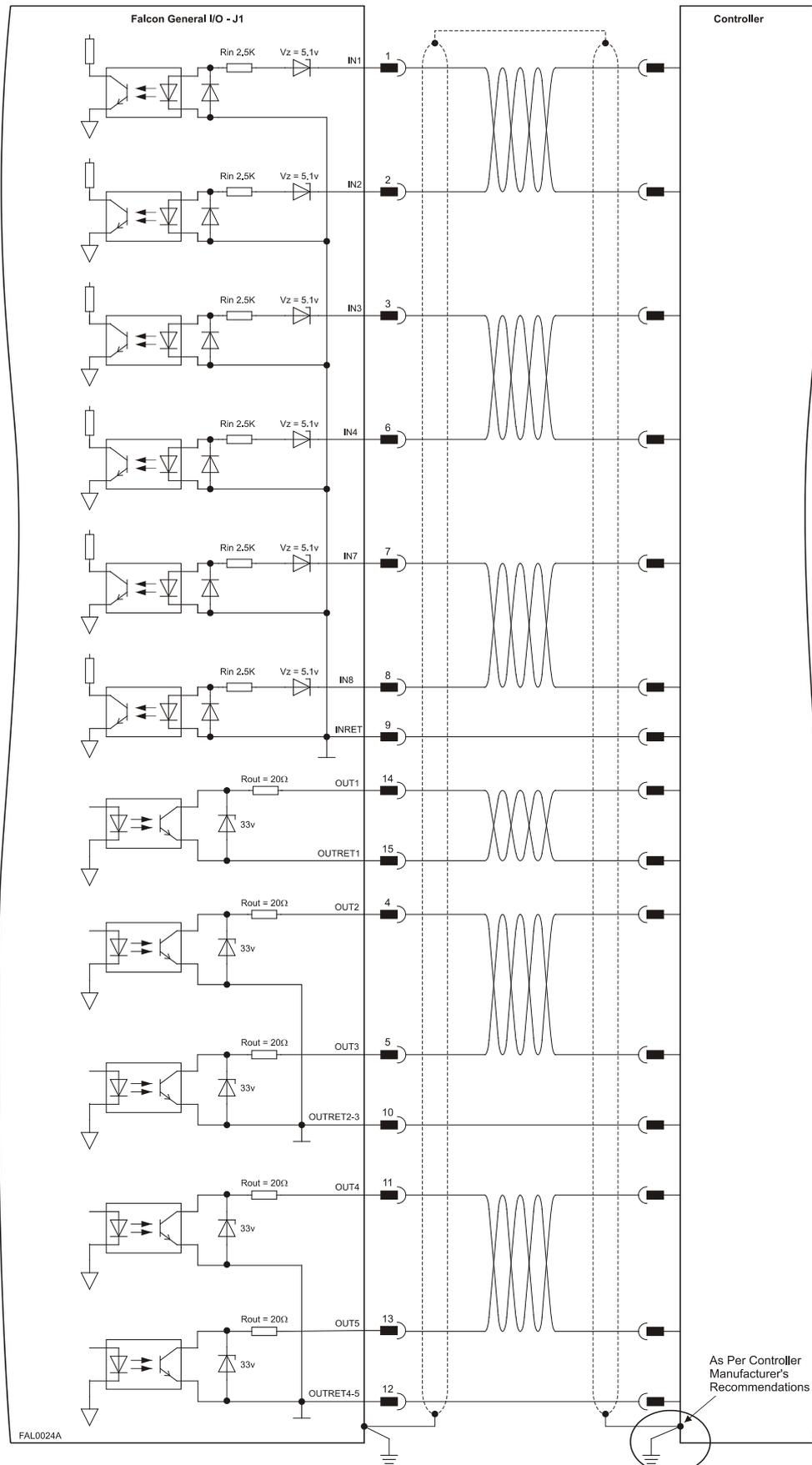


Figure 23: General J1 I/O Connection Diagram

3.4.8.2. 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 3.4.4 (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.

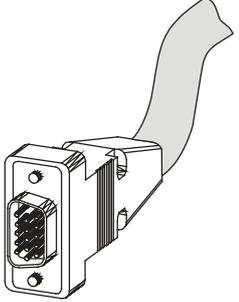
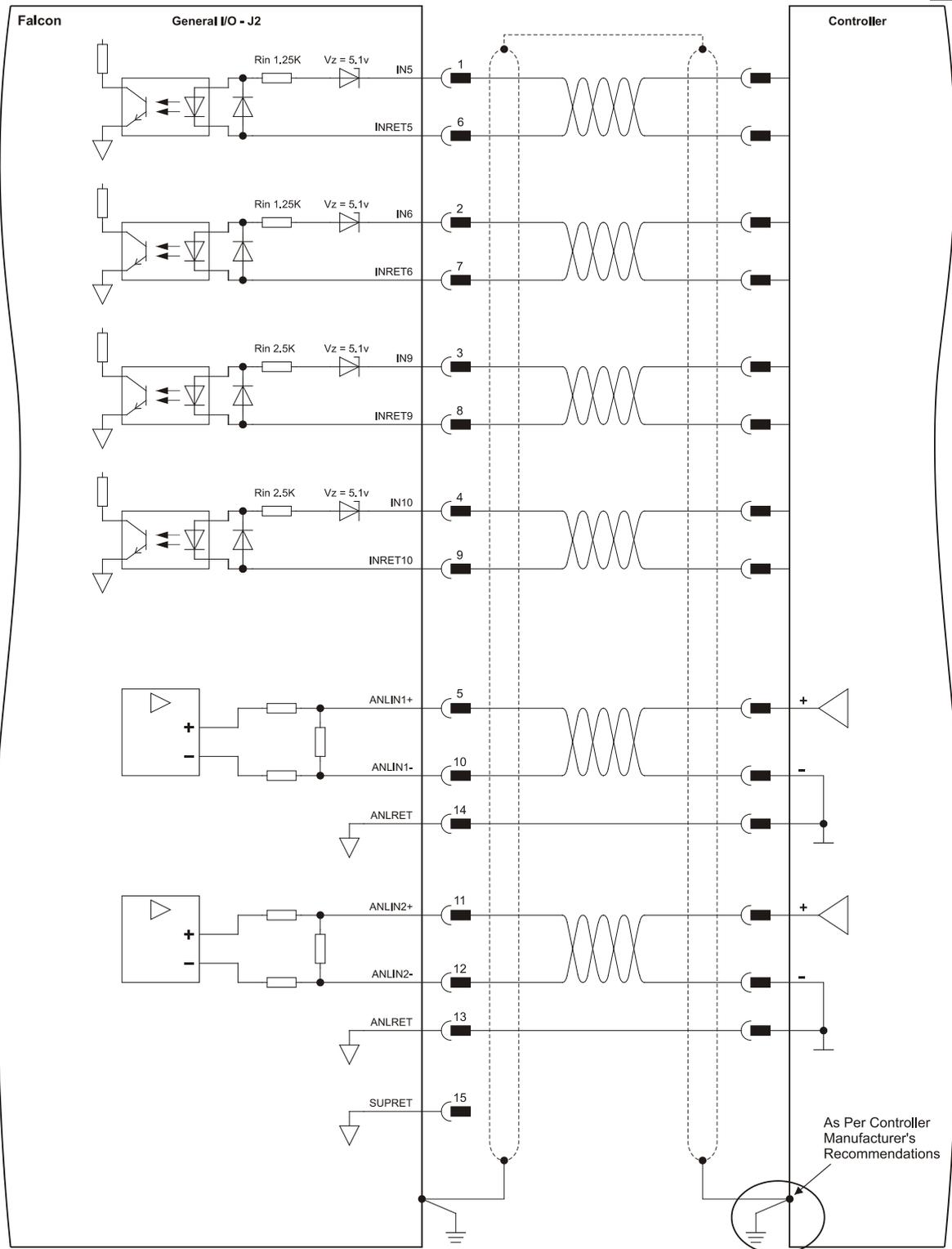
Pin	Signal	Function	Pin Positions
1	IN5	Programmable input 5 (high-speed input)	
2	IN6	Programmable input 6 (high-speed input)	
3	IN9	Programmable input 9	
4	IN10	Programmable input 10	
5	ANLIN1+	Analog input 1	
6	INRET5	Programmable input return 5 (high-speed input)	
7	INRET6	Programmable input return 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



FAL0025A

Figure 24: General Input J2 Connection Diagram

3.4.9. 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 Falcon.

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

- a. RS-232, full duplex
- b. CAN

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

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

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

3.4.9.1. 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.

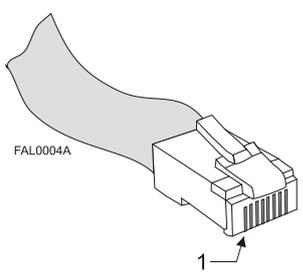
Pin	Signal	Function	Pin Locations
1,2	N/A	—	
3	Tx	RS-232 transmit	
4	—	—	
5	COMRET	Communication return	
6	Rx	RS-232 receive	
7, 8	N/A	—	

Table 15: RS-232 Cable - Pin Assignments

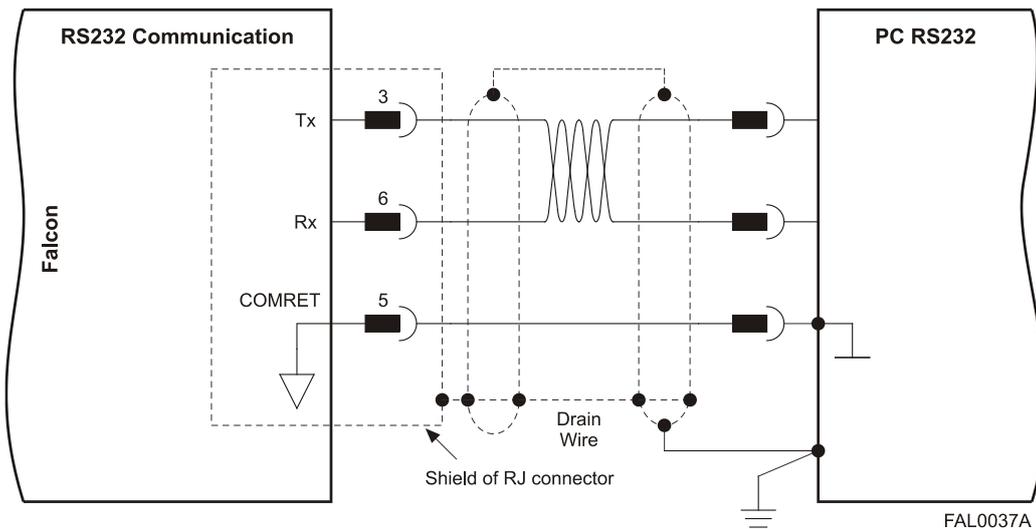


Figure 25: RS-232 Connection Diagram

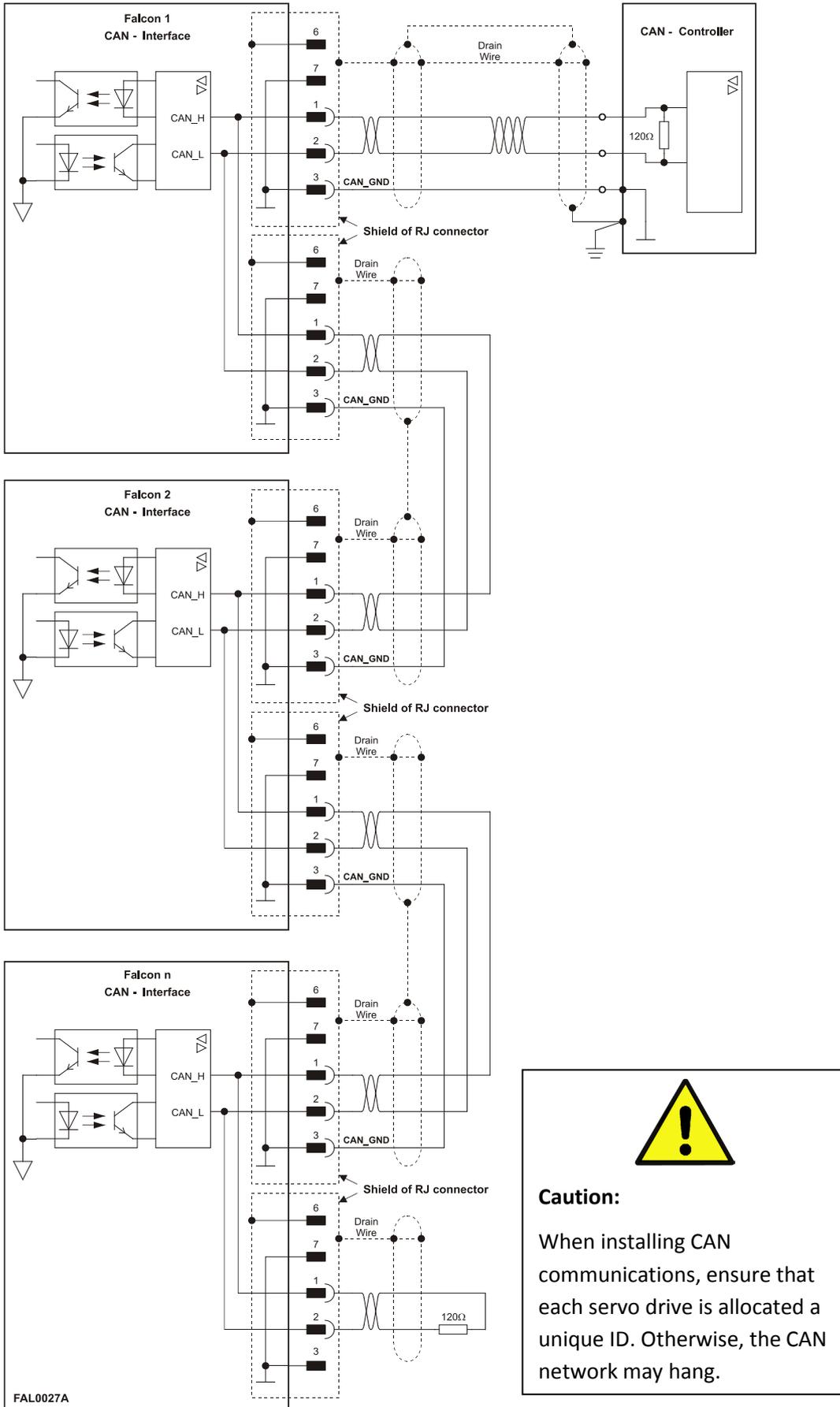
3.4.9.2. CAN Communication

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 Position
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



Caution:

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

Figure 26: CAN Connection Diagram

3.5. Powering Up

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

3.6. Initializing the System

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

4.1.1. Motion Control Modes

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

4.1.2. Advanced Positioning Motion Control Modes

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

4.1.3. Advanced Filters and Gain Scheduling

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

4.1.4. Fully Programmable

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

4.1.5. Feedback Options

- Incremental Encoder – up to 20 Mega-Counts (5 Mega-Pulse) 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

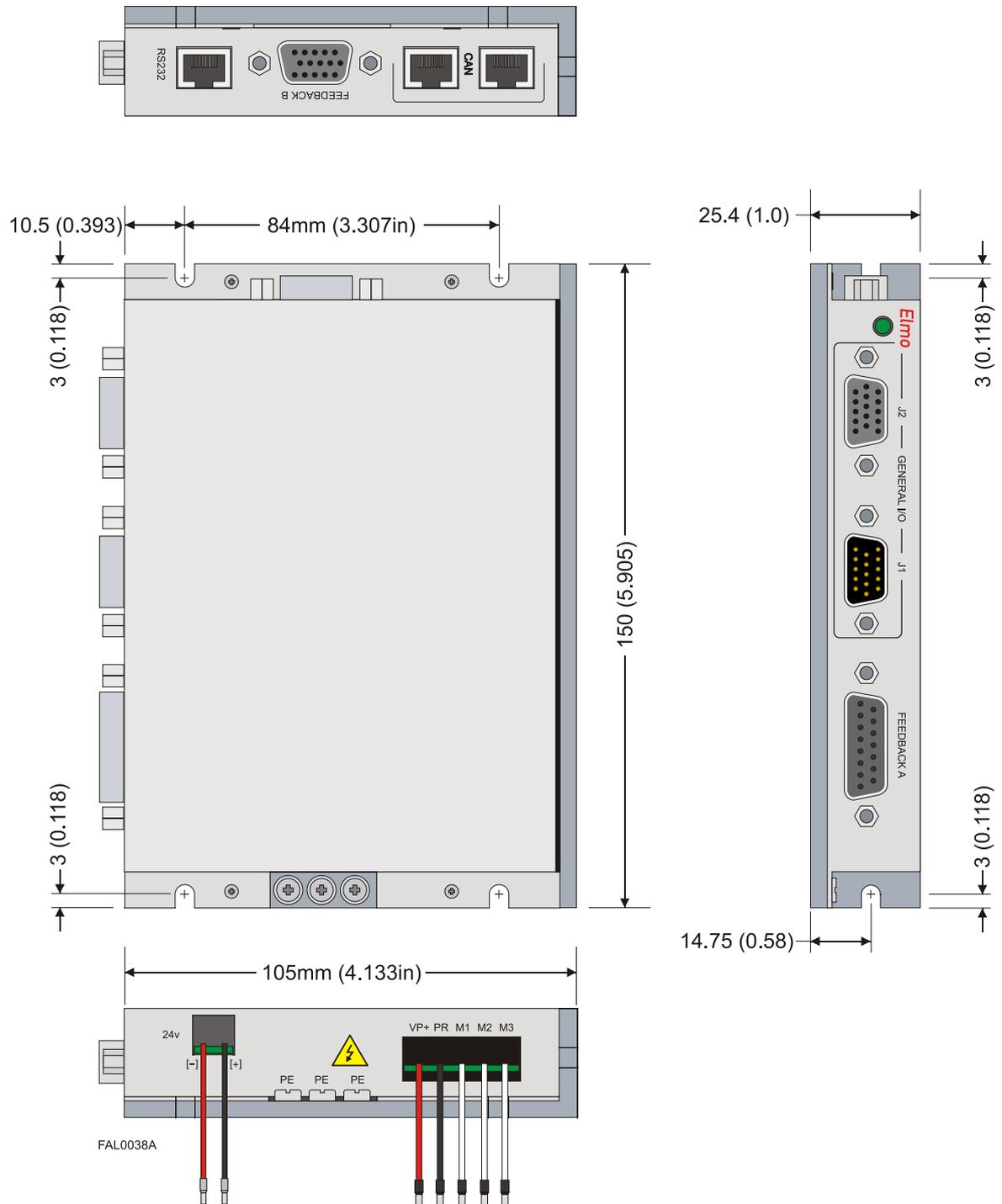
4.1.6. Input/Output

- 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

4.1.7. 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 error
 - Current limits

4.2. Falcon Dimensions



4.3. Power Ratings

Feature	Units	15/60	30/60	15/100	30/100	15/200
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	720	1440	1200	2400	2400
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	15	30	15	30	15
Sinusoidal continuous RMS current limit (Ic)	A	10.6	21.2	10.6	21.2	10.6
Peak current limit	A	2 x Ic				
Weight	g (oz)	640 g (22.6 oz)				
Dimensions	mm (in)	150 x 25.4 x 105 (5.9" x 1" x 4.1")				
Digital in/Digital out/Analog in		10/5/2				
Mounting method		Panel Mount				

4.4. Environmental Conditions

The ExtriQ products are designed, manufactured and tested to meet extreme environmental conditions. The **ExtriQ durability** is qualified, verified and tested according to the most severe environmental, EMC and safety standards exceeding the traditional and senior military Standards.

The ExtriQ series of drives support the following extended environmental conditions.

Feature	Operation Conditions	Range
Ambient Temperature Range	Non-operating conditions	-50 °C to +100 °C (-58 °F to 212 °F)
	Operating conditions	-40 °C to +70 °C (-40 °F to 160 °F)
Temperature Shock	Non-operating conditions	-40 °C to +70 °C (-40 °F to 160 °F) within 3 min
Altitude	Non-operating conditions	Unlimited
	Operating conditions	-400 m to 12,000 m (-1312 to 39370 feet)
Humidity	Non-operating conditions	Up to 95% non-condensing humidity at 35 °C (95 °F)
	Operating conditions	Up to 95% non-condensing humidity at 25 °C (77 °F), up to 90% non-condensing humidity at 42 °C (108 °F)
Vibration	Operating conditions	20 Hz to 2000 Hz, 14.6 g
Mechanical Shock	Non-operating conditions	±40 g; Half sine, 11 msec
	Operating conditions	±20 g; Half sine, 11 msec

4.5. Falcon Connections

The following connectors are used for wiring the Falcon.

Pins	Type	Maker & Part No.	Port
-	14 AWG Wires	FLDW CO311-14 Rychem	VP+, PR M1, M2, M3
3	M4 screws		PE, PE, PE
-	20 AWG wires	FLDW CO311-20 Rychem	24v

Connector Location

Table 17: Connectors on the Bottom of the Falcon

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 Falcon

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 Falcon

4.5.1. Backup Supply (Optional)

Feature	Details
Auxiliary power supply	DC source only

Feature	Details
Auxiliary supply input voltage	24 V, 13 Vmin to 40 Vmax
Auxiliary supply input power	10 W

Note: The Falcon can operate without a 24 Volt backup power supply

4.6. Control Specifications

4.6.1. Current Loop

Feature	Details
Controller type	Vector, digital
Compensation for bus voltage variations	“On-the-fly” gain scheduling
Motor types	<ul style="list-style-type: none"> • AC brushless (sinusoidal) • DC brushless (trapezoidal) • DC brush • Linear motors • Moving coils
Current control	<ul style="list-style-type: none"> • Fully digital • Sinusoidal with vector control • Programmable PI control filter based on a pair of PI controls of AC current signals and constant power at high speed
Current loop bandwidth	< 2.5 kHz
Current sampling time	Programmable 70 to 100 μsec
Current sampling rate	Up to 16 kHz; default 11 kHz

4.6.2. Velocity Loop

Feature	Details
Controller type	PI
Velocity control	<ul style="list-style-type: none"> Fully digital Programmable PI and FFW control filters On-the-fly gain scheduling Automatic, manual and advanced manual tuning
Velocity and position feedback options	<ul style="list-style-type: none"> Incremental Encoder Digital Halls Interpolated Analog (Sine/Cosine) Encoder (optional) Resolver (optional) <p>Note: With all feedback options, 1/T with automatic mode switching is activated (gap, frequency and derivative).</p>
Velocity loop bandwidth	< 350 Hz
Velocity sampling time	140 to 200 μ sec (x2 current loop sample time)
Velocity sampling rate	Up to 8 kHz; default 5.5 kHz
Velocity command options	<ul style="list-style-type: none"> Analog Internally calculated by either jogging or step <p>Note: All software-calculated profiles support on-the-fly changes.</p>

4.6.3. Position Loop

Feature	Details
Controller type	"1-2-4" PIP
Position command options	<ul style="list-style-type: none"> Software Pulse and Direction
Position loop bandwidth	< 80 Hz
Position sampling time	280 to 400 μ sec (x 4 current loop sample time)
Position sampling rate	Up to 4 kHz; default 2.75 kHz

4.7. Feedbacks

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

4.7.1. Feedback Supply Voltage

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

4.7.2. Incremental Encoder Input

Feature	Details
Encoder format	<ul style="list-style-type: none"> • 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: \pm 7 V Differential mode: \pm 7 V

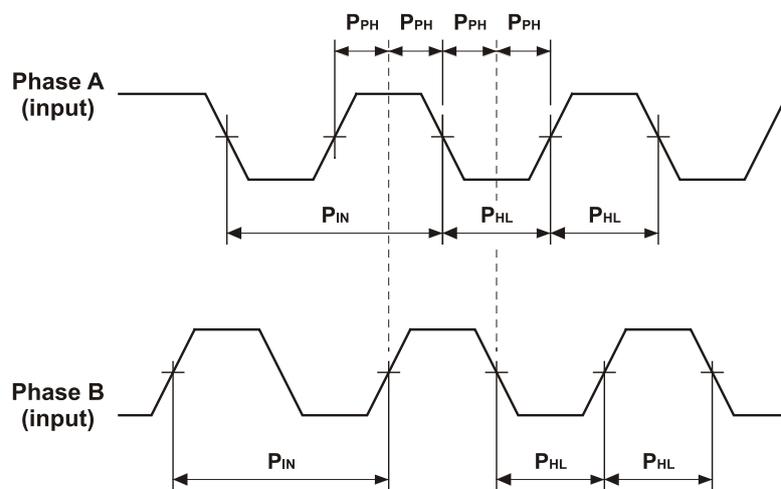


Figure 27: Encoder Phase Diagram

4.7.3. Digital Halls

Feature	Details
Halls inputs	<ul style="list-style-type: none"> • H_A, H_B, H_C. • Single ended inputs • Built in hysteresis for noise immunity.
Input voltage	Nominal operating range: $0\text{ V} < V_{\text{In_Hall}} < 5\text{ V}$ Maximum absolute: $-1\text{ V} < V_{\text{In_Hall}} < 15\text{ V}$ High level input voltage: $V_{\text{InHigh}} > 2.5\text{ V}$ Low level input voltage: $V_{\text{InLow}} < 1\text{ V}$
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	$f_{\text{MAX}} : 2\text{ kHz}$

4.7.4. Interpolated Analog (Sine/Cosine) Encoder

Feature	Details
Analog encoder format	Sine and Cosine signals
Analog input signal level	<ul style="list-style-type: none"> • Offset voltage: 2.2 V – 2.8 V • Differential, 1 V peak to peak
Input resistance	Differential 120 Ω
Maximum analog signal frequency	$f_{\text{MAX}} : 250\text{ kHz}$
Interpolation multipliers	Programmable: x4 to x4096
Maximum “counts” frequency	80 megacounts/sec “internally”
Automatic errors correction	Signal amplitudes mismatch Signal phase shift Signal offsets

4.7.5. Resolver

Feature	Details
Resolver format	<ul style="list-style-type: none"> • Sine/Cosine • Differential
Input resistance	Differential 2.49 k Ω
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 Falcon
Reference current	up to ± 50 mA

4.7.6. 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 k Ω
Input resistance for TAC2+, TAC2-	100 k Ω
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.

4.7.7. Potentiometer

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

4.7.8. Encoder Outputs

Feature	Details
Encoder output format	<ul style="list-style-type: none"> • A, B, Index • Differential outputs • Quadrature
Interface	RS-422
Port B1 output current capability	<ul style="list-style-type: none"> ▪ Driving differential loads of 200 Ω on INDEX/INDEX-, CHB/CHB- and CHA/CHA- pairs
Port B2 output current capability	<ul style="list-style-type: none"> ▪ INDEXO/INDEXO-, CHBO/CHBO- and CHAO/CHAO- pairs are not loaded
Available as options	<ul style="list-style-type: none"> • 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

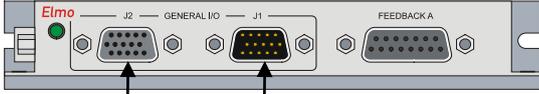
4.8. I/Os

The Falcon has:

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

4.8.1. Digital Input Interfaces

Feature	Details
Type of input	<ul style="list-style-type: none"> • Optically isolated • Single ended • PLC level
Input current	$I_{in} = \frac{V_{in} - 6.5V}{2500\Omega}$ <p>* $I_{in} = 2.2\text{ mA}$ for $V_{in} = 12\text{ V}$</p>
Input current for high speed inputs	$I_{in} = \frac{V_{in} - 6.5V}{1250\Omega}$ <p>* $I_{in} = 4.4\text{ mA}$ for $V_{in} = 12\text{ V}$</p>
High-level input voltage	$12\text{ V} < V_{in} < 30\text{ V}$, 24 V typical
Low-level input voltage	$0\text{ V} < V_{in} < 6.5\text{ V}$
Minimum pulse width	$> 4 \times TS$, where TS is sampling time
Execution time (all inputs): the time from application of voltage on input until execution is complete	<p>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: $0 < T < 4 \times TS$</p> <p>If input is set to General input, execution depends on program. Typical execution time: $\cong 0.5\text{ msec}$.</p>
High-speed inputs - minimum pulse width, in high-speed mode (IN5 - IN6)	<p>$T < 5\ \mu\text{sec}$</p> <p>Notes:</p> <ul style="list-style-type: none"> • 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.

Feature	Details
Connector location	 <p>J2: General purpose I/O J1: General purpose I/O</p>

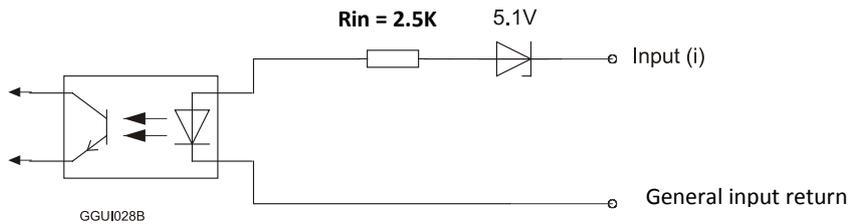


Figure 28: Digital Input Schematic

4.8.2. Digital Output Interface

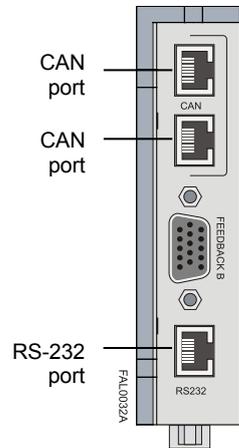
Feature	Details	Connector Location
Type of output	<ul style="list-style-type: none"> Optically isolated Open collector and open emitter 	 <p>J2: General Purpose I/O</p> <p>J1: General Purpose I/O</p>
Maximum supply output (VCC)	30 V	
Max. output current $I_{out} (max) (V_{out} = Low)$	$I_{out} (max) \leq 15 \text{ mA}$	
VOL at maximum output voltage (low level)	$V_{out} (on) \leq 0.3 \text{ V} + 0.02 * I_{out} (mA)$	
R_L	<p>The external resistor R_L must be selected to limit the output current to no more than 15 mA.</p> $R_L = \frac{VCC - VOL}{I_{out} (max)}$	

Feature	Details	Connector Location
Executable time	<p>If output is set to one of the built-in functions — Home flag, Brake or AOK — execution is immediate upon detection: $0 < T < 4 \times TS$</p> <p>If output is set to General output and is executed from a program, the typical time is approximately 0.5 msec.</p>	 <p>Digital Output Schematic</p>

4.8.3. 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

4.9. Communications

Specification	Details	Connector Location
RS-232	Signals: <ul style="list-style-type: none"> • RxD , TxD , GND • Full duplex, serial communication for setup and control. • Baud Rate of 9,600 to 115,200 bit/sec. 	 <p>The diagram shows a vertical panel with several connectors. From top to bottom: two CAN ports (RJ45), a Feedback B connector (D-sub), and an RS-232 port (RJ45). Labels with leader lines point to the top two CAN ports and the RS-232 port. The model number 'FAL0032A' is printed vertically on the left side of the panel.</p>
CAN	CAN bus Signals: <ul style="list-style-type: none"> • CAN_H, CAN_L, CAN_GND • Maximum Baud Rate of 1 Mbit/sec. Version: <ul style="list-style-type: none"> • DS 301 V4.01 Device Profile (drive and motion control): <ul style="list-style-type: none"> • DS 402 	

4.10. Pulse-Width Modulation (PWM)

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

4.11. 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)

4.12. 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 style="list-style-type: none"> • 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

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)