SimplIQ Line

Guitar
Digital Servo Drive
Installation Guide

P/N: GUI – 17/200I
S/N: GUI5555555

61mm
(2.4 inch)

80mm
(3.15 inch)

24.5 mm
(0.96 inch)

October 2017 (Ver. 1.603)

Elmo
Motion Control

www.elmomc.com

Notice

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

- This guide contains proprietary information belonging to Elmo Motion Control Ltd. Such information is supplied solely for the purpose of assisting users of the Guitar 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.

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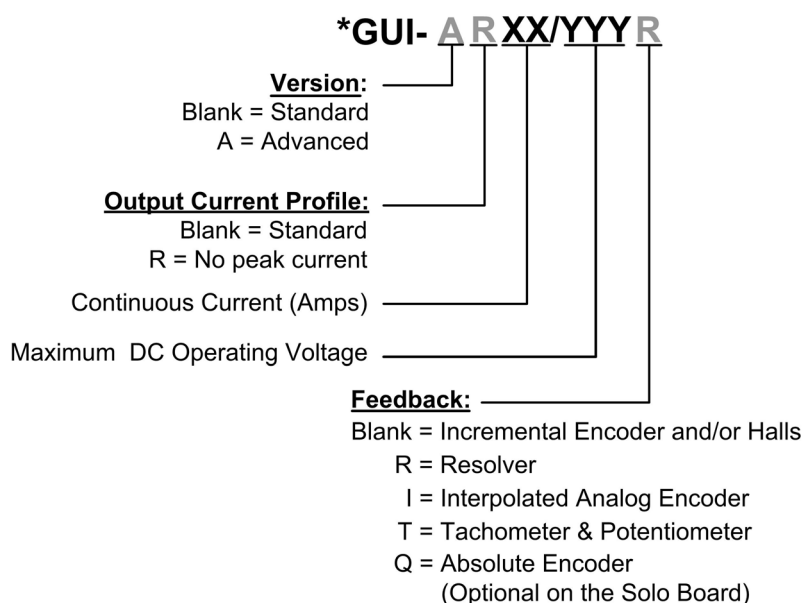- Information in this document is subject to change without notice.

Catalog Number

*GUI- A R XX/YYY R

Version:
Blank = Standard
A = Advanced

Output Current Profile:
Blank = Standard
R = No peak current

Continuous Current (Amps)

Maximum DC Operating Voltage

Feedback:
Blank = Incremental Encoder and/or Halls
R = Resolver
I = Interpolated Analog Encoder
T = Tachometer & Potentiometer
Q = Absolute Encoder
(Optional on the Solo Board)

*Models with power rating R75/48, and R75/60, are purchased without a plastic casing.

Evaluation Board

Catalog Number: EVA-WHI/GUI/BEL (can be ordered separately). For further details, see the documentation for this evaluation board (MAN-EVLBRD-WHI_BEL_GUI-UG.pdf).

Revision History

Version		Details
1.0	April 2008	Initial release
1.1	July 2008	Heat dissipation data added in Chapter 3
1.2	April 2009	Updated Section 3.8.3; added Section 3.16
1.3	March 2010	MTCR 01-010-01: Updated Figure 22
1.4	July 2010	Updated Sections 3.4 and 4.1.8
1.5	July 2012	Formatted according to new template "Metronome" was replaced by the "Composer" software.
1.501	February 2013	Added a caution and recommendation on the type of cleaning solution to use for the Elmo unit.
1.502	March 2013	The maximum auxiliary supply voltage was added to the Power Ratings table General document updates
1.503	March 2013	The Power Ratings table (Section 4.3) was updated.
1.600	June 2013	Addition 20/200, R75/48, and R75/60 models
1.601	July 2014	General format changes
1.602	June 2015	Small changes to Part number and similarly, to section 4.3.
1.603	October 2017	Updated Warranty Information section 1.5 and updated the part number label in section 3.2

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Chapter 1: Safety Information

In order to operate the Guitar servo drive safely, 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 Guitar 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 Guitar 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 Guitar from all voltage sources before it is opened for servicing.

- The Guitar servo drive contains grounding conduits for electric current protection. Any disruption to these conduits may cause the instrument to become hot (live) and dangerous.

- After shutting off the power and removing the power source from your equipment, wait at least 1 minute before touching or disconnecting parts of the equipment that are normally loaded with electrical charges (such as capacitors or contacts). Measuring the electrical contact points with a meter, before touching the equipment, is recommended.

1.2.   Cautions

- The Guitar 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.

- When connecting the Guitar to an approved auxiliary power supply, connect it through a line that is separated from hazardous live voltages using reinforced or double insulation in accordance with approved safety standards.

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

2.1. Drive Description

The Guitar series of digital servo drives is designed to deliver "the highest density of power and intelligence". The Guitar delivers up to **4.8 kW of continuous power** or **8.0 kW of peak power** in a 119. 6 cc (6.95 in³) package (80 x 24.5 x 61 mm or 3.15" x 0.965" x 2.4").

The Guitar is designed for OEMs. It operates 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. It is designed for use with any type of sinusoidal and trapezoidal commutation, with vector control. The Guitar 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 Guitar servo drive is easily set up and tuned using Elmo's *Composer* software tools. This Windows-based application enables users to quickly and simply configure the servo drive for optimal use with their motor. The Guitar, as part of the *SimplIQ* product line, is fully programmable with the Elmo *Composer* motion control language.

Power to the Guitar is provided by an isolated DC power source (not included with the Guitar). A "smart" control-supply algorithm enables the Guitar to operate with only this power supply with no need for an auxiliary power supply for the logic.

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

If backup power is not needed, two terminals (VP and VL) must be connected together by the user. In this way there is no need for a separate control/logic supply.

The Guitar is a PCB mounted device which enables efficient and economic implementation.

The Guitar is available in two models:

- The Standard Guitar is a basic servo drive which operates in current, velocity and position modes including Follower and PT & PVT. It operates simultaneously via RS-232 and CAN DS 301, DS 305, DS 402 communications and features a third-generation programming environment.

- The Advanced Guitar includes all the motion capabilities and communication options included in the Standard model, as well as advanced positioning capabilities: ECAM, Dual Loop and increased program size.

Both versions operate with RS-232 and CAN communication.

2.2.   Product Features

2.2.1.   Current Control

- Fully digital

- Sinusoidal commutation with vector control or trapezoidal commutation with encoder and/or digital Hall sensors

- 12-bit current loop resolution

- Automatic gain scheduling, to compensate for variations in the DC bus power supply

2.2.2.   Velocity Control

- Fully digital

- Programmable PI and FFW (feed forward) control filters

- Sample rate two times current loop sample time

- "On-the-fly" gain scheduling

- Automatic, manual and advanced manual tuning and determination of optimal gain and phase margins

2.2.3.   Position Control

- Programmable PIP control filter

- Programmable notch and low-pass filters

- Position follower mode for monitoring the motion of the slave axis relative to a master axis, via an auxiliary encoder input

- Pulse-and-direction inputs

- Sample time: four times that of the current loop

- Fast event capturing inputs

- PT and PVT motion modes

- Fast output compare (OC)

2.2.4.　　Advanced Position Control

This relates to the 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

- Dual (position/velocity) loop

2.2.5.　　Communication Options

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

- RS-232 serial communication

- CAN for fast communication in a multi-axis distributed environment

2.2.6.　　Feedback Options

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

- Digital Halls – up to 2 kHz

- Incremental Encoder with Digital Halls for commutation – up to 20 Mega-Counts per second for encoder

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

  - Internal interpolation - up to x4096
  - Automatic correction of amplitude mismatch, phase mismatch, signals offset
  - Auxiliary emulated, unbuffered, single-ended, encoder output

- Resolver

  - Programmable 10 to 15 bit resolution
  - Up to 512 revolutions per second (RPS)
  - Auxiliary emulated, unbuffered, single-ended, encoder output

- Tachometer, Potentiometer

- Elmo drives provide supply voltage for all the feedback options

2.2.7.　　Fault Protection

The Guitar includes built-in protection against possible fault conditions, including:
- Software error handling

- Status reporting for a large number of possible fault conditions

- Protection against conditions such as excessive temperature, under/over voltage, loss of commutation signal, short circuits between the motor power outputs and between each output and power input/return

- Recovery from loss of commutation signals and from communication errors
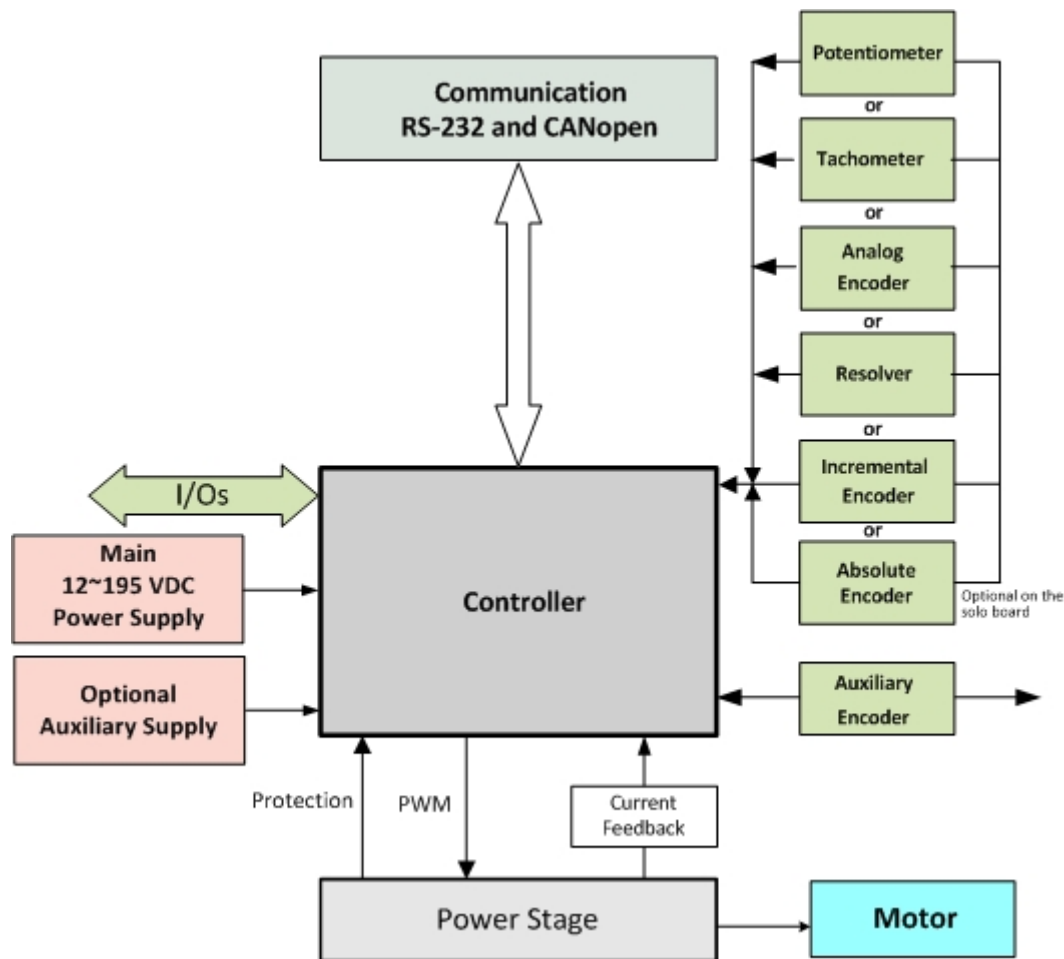
2.3.   System Architecture

Figure 1: Guitar System Block Diagram

2.4.   How to Use this Guide

In order to install and operate your Elmo Guitar 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 Guitar.

- Chapter 4, *Technical Specifications,* lists all the drive ratings and specifications.

Upon completing the instructions in this guide, your Guitar 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.
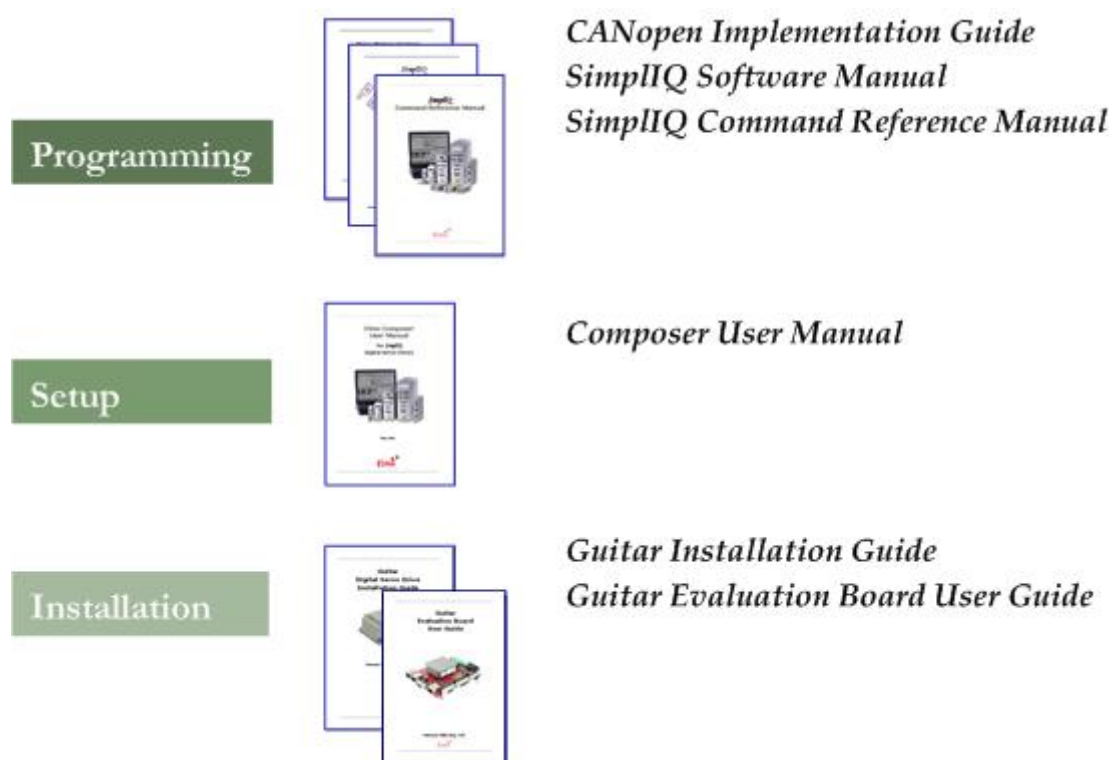
Figure 2: Elmo Digital Servo Drive Documentation Hierarchy

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

- The *SimplIQ Software Manual,* which describes the comprehensive software used with the Guitar

- The *SimplIQ Command Reference Manual,* which describes, in detail, each software command used to manipulate the Guitar motion controller

- The Composer *Software Manual,* which includes explanations of all the software tools that are part of Elmo's Composer software environment

- The Guitar Evaluation Board User Guide contains information about how to use the Guitar Evaluation Board and Cable Kit

Chapter 3: Installation

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

3.1. Site Requirements

You can guarantee the safe operation of the Guitar 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 non-condensing humidity	90%
Operating area atmosphere	No flammable gases or vapors permitted in area
Models for extended environmental conditions are available.	

Caution:

The Guitar 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.

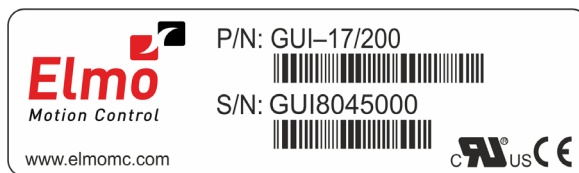## 3.2. Unpacking the Drive Components

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

- The Guitar servo drive

- The Composer software and software manual

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

To unpack the Guitar:

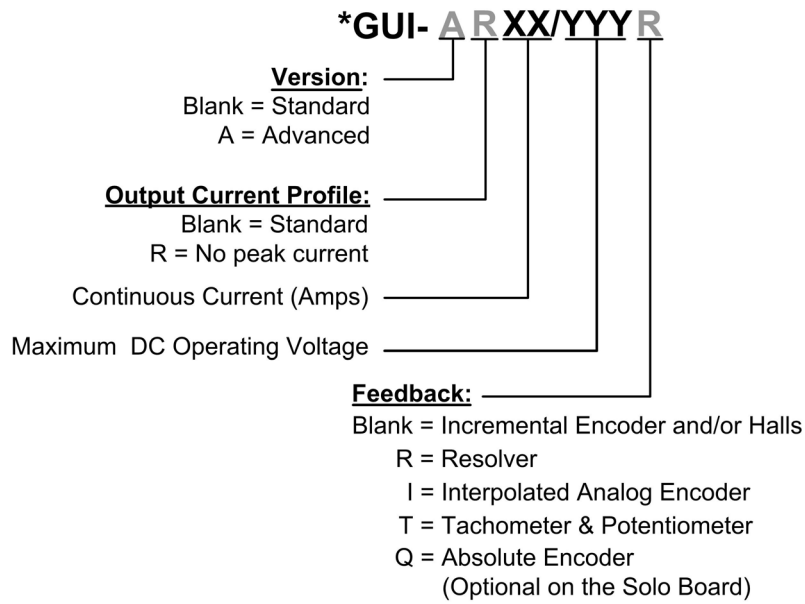1. Carefully remove the servo drive from the box and the Styrofoam.

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

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

*GUI- A R XX/YYY R

Version:
Blank = Standard
A = Advanced

Output Current Profile:
Blank = Standard
R = No peak current

Continuous Current (Amps)

Maximum DC Operating Voltage

Feedback:
Blank = Incremental Encoder and/or Halls
R = Resolver
I = Interpolated Analog Encoder
T = Tachometer & Potentiometer
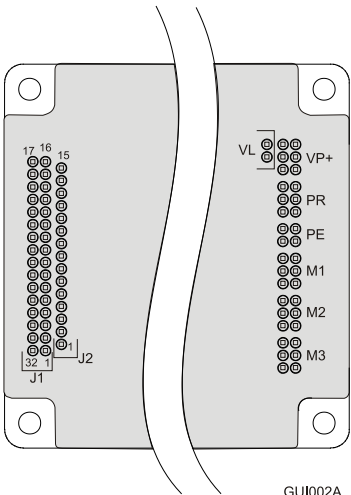Q = Absolute Encoder
  (Optional on the Solo Board)

*Models with power rating R75/48, and R75/60, are purchased without a plastic casing.

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

3.3.   Pinouts

The Guitar has nine connectors.

3.3.1.   Connector Types

Pins	Type	Port	Function	Connector Location
2x16	2 mm Pitch 0.51 mm SQ	J1	I/O, COMM, Auxiliary Feedback	
15		J2	Main Feedback, Analog Input, LED	
2		VL	Auxiliary power input	
6		VP+	Positive power input	
6		PR	Power input return	
4		PE	Protective earth	
6		M1	Motor power output 1	
6		M2	Motor power output 2	
6		M3	Motor power output 3	

3.3.2.   Connector J1

Connector J1: Main Feedback and Analog Input functions

Pin (J1)	Signal	Function
1	RS232_RX	RS-232 receive
2	RS232_TX	RS-232 Transmit
3	RS232_COMRET	Communication return
4	AUX PORT CHA	Auxiliary port CHA (bidirectional)
5	AUX PORT CHB	Auxiliary port CHB (bidirectional)
6	SUPRET	Supply return
7	OUT1	Programmable digital output 1
8	OUT2	Programmable digital output 2
9	OUT3	Programmable digital output 3
10	OUT4	Programmable digital output 4
11	IN1	Programmable digital input 1
12	IN2	Programmable digital input 2
13	IN3	Programmable digital input 3
14	IN4	Programmable digital input 4
15	IN5	Programmable digital input 5
16	IN6	Programmable digital input 6
17	INRET6	Programmable digital input 6 return
18	INRET5	Programmable digital input 5 return
19	INRET4	Programmable digital input 4 return
20	INRET3	Programmable digital input 3 return
21	INRET2	Programmable digital input 2 return
22	INRET1	Programmable digital input 1 return
23	OUTRET4	Programmable digital output 4 return
24	OUTRET3	Programmable digital output 3 return
25	OUTRET2	Programmable digital output 2 return
26	OUTRET1	Programmable digital output 1 return
27	+5 V	Encoder +5 V supply voltage. Maximum output current: 200 mA

Pin (J1)	Signal	Function
28	COMRET	Common return
29	AUX PORT INDEX	Auxiliary port index (bidirectional)
30	CAN_COMRET	CAN communication return
31	CAN_L	CAN_L busline (dominant low)
32	CAN_H	CAN_H busline (dominant high)

3.3.3.   Connector J2

Connector J2: Communications, Auxiliary Feedback and I/O functions

Pin (J2)	Signal	Function
1	+5V	Encoder/Hall +5V supply voltage Maximum output current: 200 mA
2	SUPRET	Supply return
3	ANALIN1+	Analog input 1+
4	ANALIN1-	Analog input 1-
5	CHA	Channel A input
6	CHA-	Channel A input complement
7	CHB	Channel B input
8	CHB-	Channel B input complement
9	INDEX+	Index input
10	INDEX-	Index input complement
11	HA	Hall sensor A input
12	HB	Hall sensor B input
13	HC	Hall sensor C input
14	LED_2_OUT	Bi-color indication output 2 (Cathode)
15	LED_1_OUT	Bi-color indication output 1 (Anode)

3.4. Mounting the Guitar

The Guitar was designed for mounting on a printed circuit board (PCB) via 2 mm pitch 0.51 mm square pins. When integrating the Guitar into a device, be sure to leave about 1 cm (0.4") outward from the heatsink to enable free air convection around the drive. We recommend that the Guitar be soldered directly to the board. Alternatively, though this is not recommended, the Guitar can be attached to socket connectors mounted on the PCB. If the PCB is enclosed in a metal chassis, we recommend that the Guitar be screw-mounted to it as well to help with heat dissipation. The Guitar has screw-mount holes on each corner of the heatsink for this purpose.
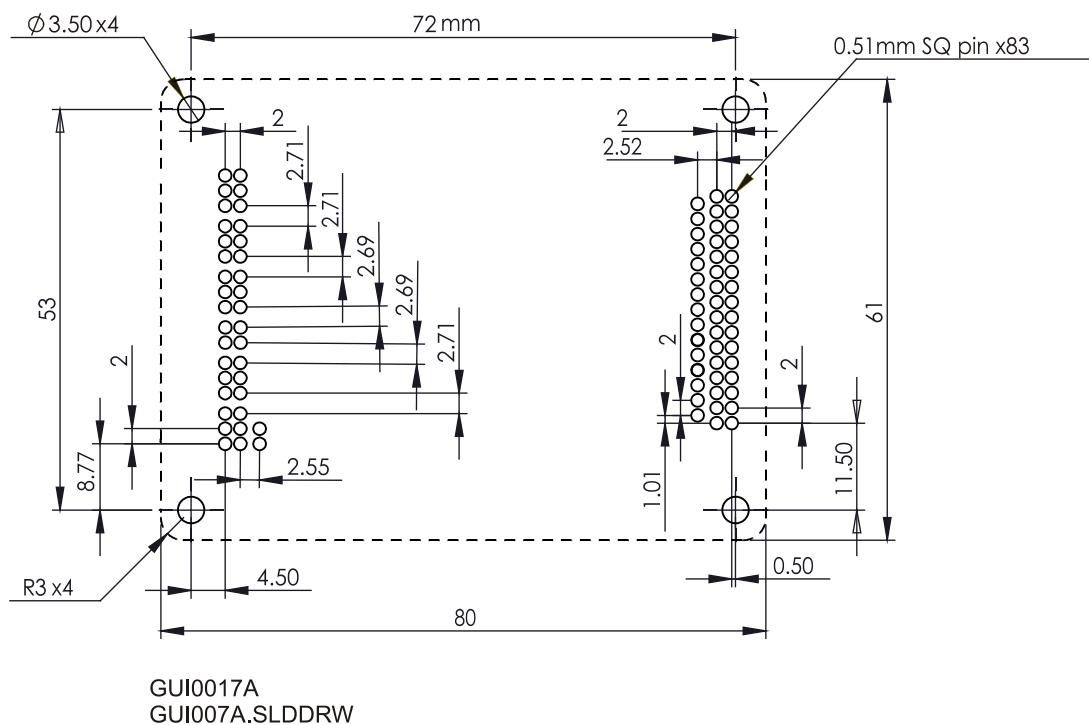

GUI0017A
GUI007A.SLDDRW

Figure 3: The Guitar Footprint

When the Guitar is not connected to a metal chassis, the application's thermal profile may require a solution for heat dissipation due to insufficient air convection. In this case, we recommend that you connect an external heatsink.

3.5.   Integrating the Guitar on a PCB

The Guitar is designed to be mounted on a PCB, either by soldering its pins directly to the PCB or by using suitable socket connectors. In both cases the following rules apply:

3.5.1.   Traces

1. The **size of the traces** on the PCB (thickness and width) is determined by the current carrying capacity required by the application.

    - The rated continuous current limit (Ic)of the Guitar is the current used for sizing the motor traces (M1, M2, M3 and PE) and power traces (VP+, PR and PE).
    - For control, feedbacks and Inputs/ outputs conductors the actual current is very small but "generous" thickness and width of the conductors will contribute to a better performance and lower interferences.

2. The **traces should be as short as possible** to minimize EMI and to minimize the heat generated by the conductors.

3. The **spacing** between the high voltage conductors (VP+, PR, M1, M2, M3, VL) must be at least:

    - Surface layer: 1.5 mm
    - Internal layer: 0.5 mm

Complying with the rules above will help satisfy UL safety standards, MIL-STD-275 and the IPC-D-275 standard for non-coated conductors, operating at voltages lower than 200 VDC.

3.5.2.   Grounds and Returns

The "Returns" of the Guitar are structured internally in a star configuration. The returns in each functional block are listed below:

Functional Block	Return Pin
Power	PR (Power Return)
Internal Switch Mode P. S.	PR (Power Return)
RS-232 Communications	RS232_COMRET (J1/3)
CAN Communications	CAN_COMRET (J1/30)
Control section	COMRET (J1/28)
Main Feedback	SUPRET (J2/2)
Aux. Feedback	SUPRET (J1/6)
Analog input	ANLRET (J2/2)

The returns above are all shorted within the Guitar in a topology that results in optimum performance.

1. When wiring the traces of the above functions, on the Integration Board, the **Returns** of each function must be **wired separately** to its designated terminal on the Guitar. **DO NOT USE A COMMON GROUND PLANE**. Shorting the commons on the Integration Board may cause performance degradation (ground loops, etc).

2. **Inputs**: The 6 inputs are optically isolated from the other parts of the Guitar. Each input has a separate floating return (INRET1 for input 1 and INRET2 for input 2, etc.). To retain isolation, the Input Return pins, as well as other conductors on the input circuit, must be laid out separately.

3. **Outputs**: The 4 outputs are optically isolated from the other parts of the Guitar. Each output has a separate floating return (OUTRET1 for output 1 and OUTRET2 for output 2, etc.) To retain isolation, the Output Return pins, as well as other conductors on the output circuit, must be laid out separately.

4. **Return Traces:** The return traces should be as large as possible, but without shorting each other, and with minimal cross-overs.

5. **Main Power Supply and Motor Traces:** The power traces must be kept as far away as possible from the feedback, control and communication traces.

6. **PE Terminal**: The PE terminal is connected directly to the Guitar's heat-sink. The heat-sink serves as an EMI common plane. The PE terminal should be connected to the system's Protective Earth. Any other metallic parts (such as the chassis) of the assembly should be connected to the Protective Earth as well.

7. Under normal operating conditions, the PE trace carries no current. The only time these traces carry current is under abnormal conditions (such as when the device has become a potential shock or fire hazard while conducting external EMI interferences directly to ground). When connected properly the PE trace prevents these hazards from affecting the drive.

> **Caution:**
> Follow these instructions to ensure safe and proper implementation. Failure to meet any of the above-mentioned requirements can result in drive/controller/host failure.
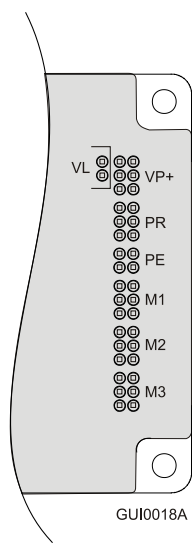
3.6.   The Guitar Connection Diagram
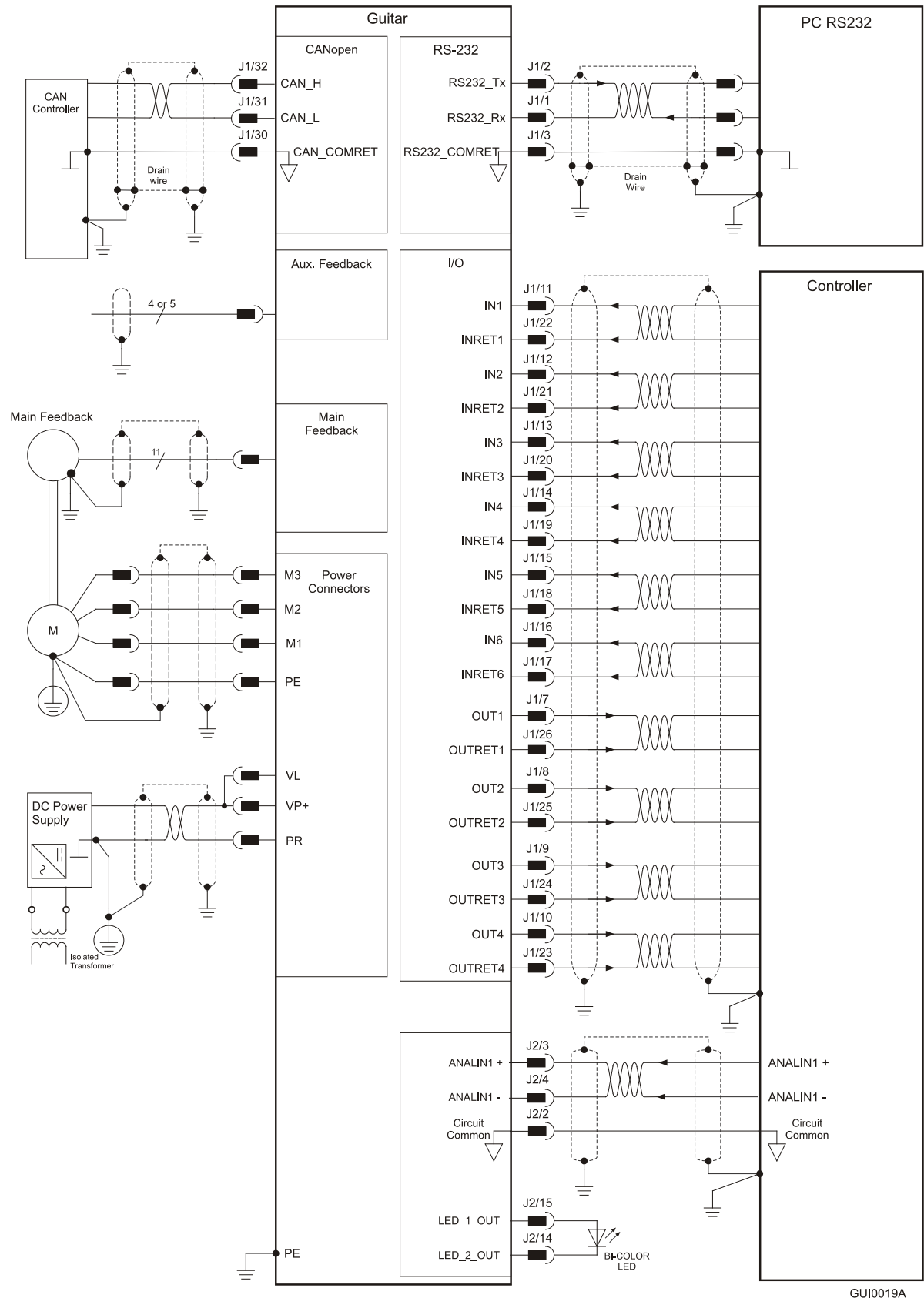
GUI0019A

Figure 4: The Guitar Connection Diagram

3.7.   Main Power and Motor Power

The Guitar receives power from the main power supply and delivers power to the motor.

Pin	Function	Cable		Pin Positions
VP+	Pos. Power input	Power		
PR	Power return	Power		
PE	Protective earth	Power		
		AC Motor	**DC Motor**	
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 drives to several motors, all should be wired in an identical manner. This will enable the same SimplIQ program to run on all drives.

Table 1: Connector for Main Power and Motor

3.7.1.   Connecting Motor Power

Connect the M1, M2, M3 and PE pins on the Guitar in the manner described in Section 3.5 (Integrating the Guitar on a PCB). The phase connection is arbitrary as the Composer will establish the proper commutation automatically during setup. However, if you plan to copy the setup to other drives, then the phase order on all copy drives must be the same.
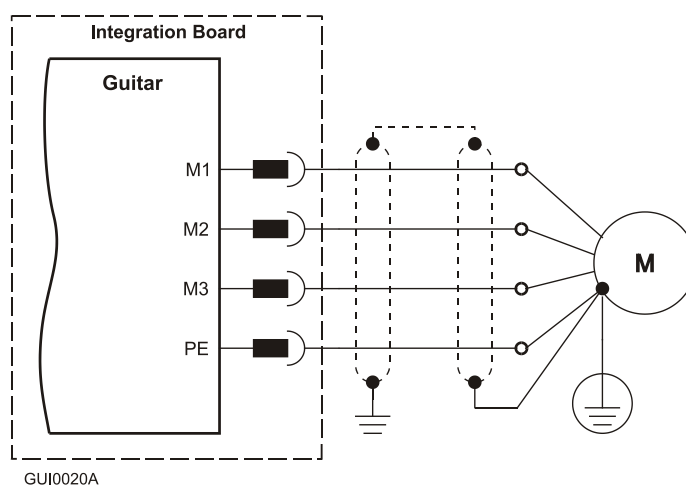

Figure 5: AC Motor Power Connection Diagram

3.7.2. Connecting Main Power

Connect the VP+, PR and PE pins on the Guitar in the manner described in Section 3.5 (Integrating the Guitar on a PCB).

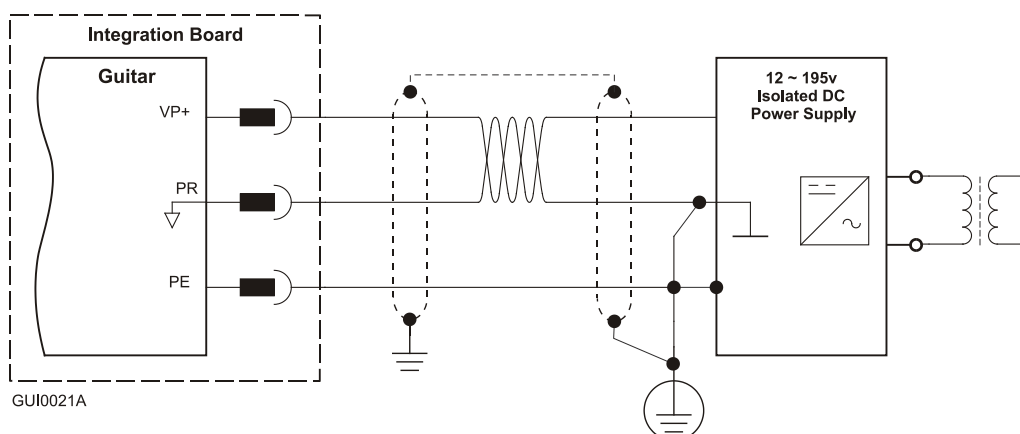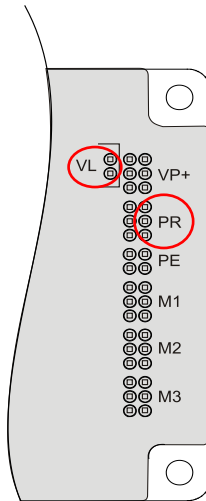**Note:** The source of the 12 to 195 VDC Main Power Supply must be isolated.

Figure 6: Main Power Supply Connection Diagram (no Auxiliary Supply)

3.8. Auxiliary Supply (for drive logic)

Notes for auxiliary supply connections:

- The source of the Auxiliary Supply must be isolated.

Connect the VL and PR pins on the Guitar in the manner described in Section 3.5 (Integrating the Guitar on a PCB).

Pin	Function	Pin Positions
VL	Auxiliary Supply Input	
PR	Supply Input Return	
⚠	**Caution:** Power from the Guitar to the motor must come from the Main Supply and **NOT** from the Auxiliary Supply.	

Table 2: Auxiliary Supply Pins

3.8.1.   Single Supply

A single isolated DC power supply can provide power for both the main power and the Auxiliary (Drive Logic) Supply. Figure 7 shows how a single supply is connected. In this configuration, there is no backup functionality upon power shutdown.
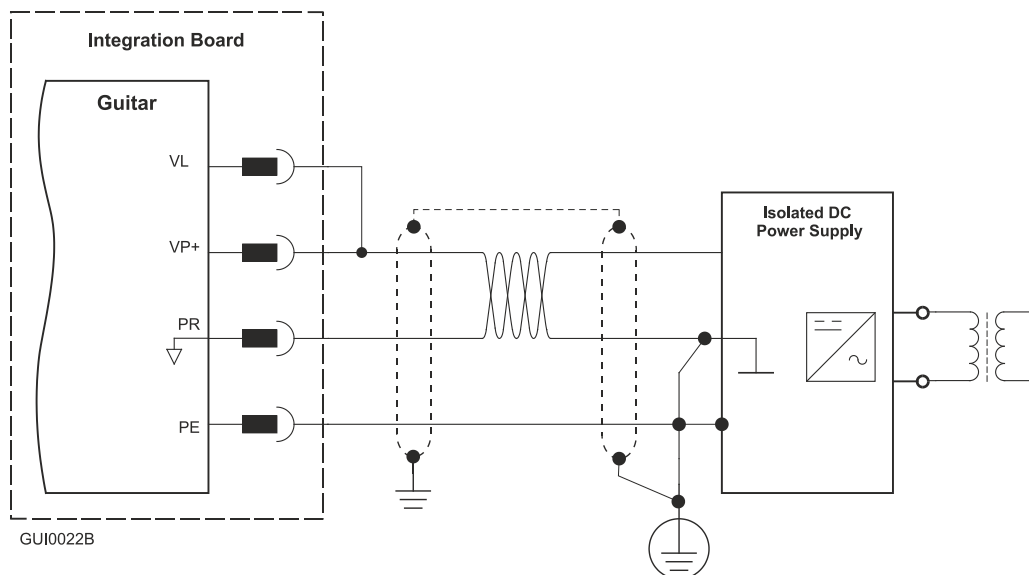

Figure 7: Single Supply for both the Main Power Supply and the Auxiliary Supply

3.8.2.   Separate Auxiliary Supply

Power to the Auxiliary Supply can be provided by a separate isolated auxiliary power supply. The configuration in Figure 8 below shows how to achieve backup functionality.
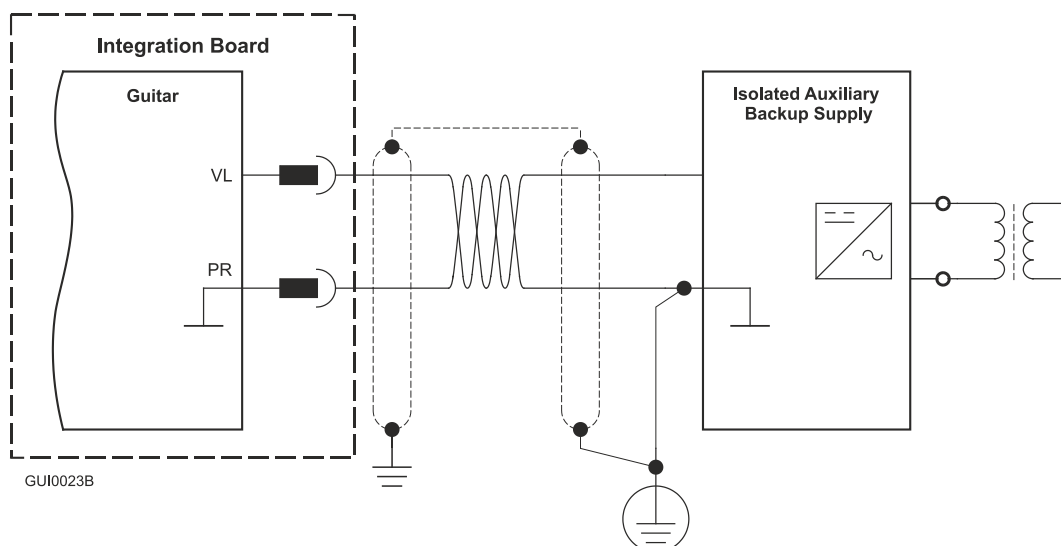

Figure 8: Separate Auxiliary Supply Connection Diagram

Caution:

The maximum voltage of the auxiliary power supply must not exceed the rated voltage of the drive specified in the Power Ratings table (Section 4.3).

3.8.3.   Shared Supply

A "Main" DC Power Supply can be designed to supply power to the drive's logic as well as to the Main Power (see Figure 7 and the upper portion of Figure 9). If backup functionality is required for continuous operation of the drive's logic in the event of a main power-out, a backup supply can be connected by implementing "diode coupling" (see the Aux. Backup Supply in Figure 9).

Note: Elmo's Evaluation Board (Catalog number: WHI-EVLBRD-1) implements diode coupling on the board. When you create your own PCB, you need to implement diode coupling.
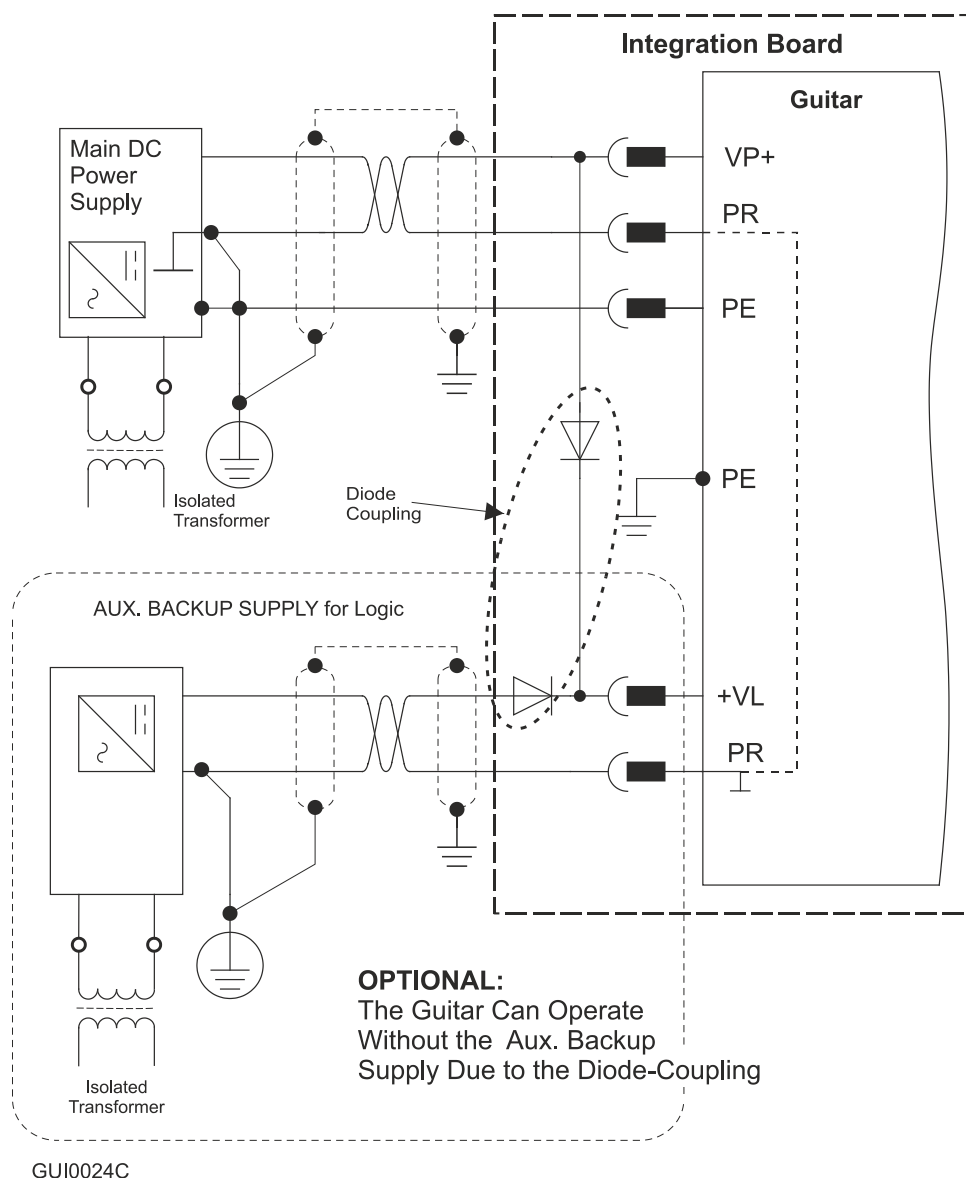

Figure 9: Shared Supply Connection Diagram

3.9.   Main Feedback

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

The Guitar can accept any one the following devices as a main feedback mechanism:

- Incremental encoder only
- Incremental encoder with digital Hall sensors
- Digital Hall sensors only
- Incremental Analog (Sine/Cosine) encoder (option)
- Resolver (option)
- Tachometer (option)
- Potentiometer (option)
- Absolute Encoder (optional on the solo board)

Pin (J2)	Incremental Encoder		Interpolated Analog Encoder		Resolver		Tachometer and Potentiometer	
	GUI- XX/YYY_		GUI -XX/YYYI		GUI -XX/YYYR		GUI- XX/YYYT	
	Signal	Function	Signal	Function	Signal	Function	Signal	Function
1	+5V	Encoder/Hall +5V supply	+5V	Encoder/Hall +5V supply	+5V	Encoder/Hall +5V supply	+5V	Encoder/Hall +5V supply
2	SUPRET	Supply return	SUPRET	Supply return	SUPRET	Supply return	SUPRET	Supply return
3	ANALIN+ is used for Analog Input							
4	ANALIN- is used for Analog Input							
5	CHA	Channel A	A+	Sine A	S1	Sine A	Tac 1+	Tacho Input 1 Pos. (20 V max)
6	CHA-	Channel A complement	A-	Sine A complement	S3	Sine A complement	Tac 1-	Tacho Input 1 Neg. (20 V max)
7	CHB	Channel B	B+	Cosine B	S2	Cosine B	Tac 2+	Tacho Input 2 Pos. (50 V max)
8	CHB-	Channel B complement	B-	Cosine B complement	S4	Cosine B complement	Tac 2-	Tacho Input 2 Neg. (50 V max)
9	INDEX	Index	R+	Reference	R1	Vref f = 1/TS, 50 mA Max	POT	Potentiometer Input (5 V Max)
10	INDEX-	Index complement	R-	Reference complement	R2	Vref complement f = 1/TS, 50 mA Max	NC	-
11	HA	Hall sensor A input	HA	-	NC	-	HA	Hall sensor A input
12	HB	Hall sensor B input	HB	-	NC	-	HB	Hall sensor B input
13	HC	Hall sensor C input	HC	-	NC	-	HC	Hall sensor C input
14	LED_2_OUT (AOKLED cathode) is used for LED indication							
15	LED_1_OUT (AOKLED anode) is used for LED indication							

Table 3: Main Feedback Pin Assignments

Integration Board

Guitar
J2
Main Feedback

			Incremental Encoder **with Hall Sensors**
HC	J2/13		Hall C
HB	J2/12		Hall B
HA	J2/11		Hall A
CHA	J2/5		CHA
CHA-	J2/6		CHA-
CHB	J2/7		CHB
CHB-	J2/8		CHB-
INDEX	J2/9		INDEX
INDEX-	J2/10		INDEX-
+5v	J2/1		Encoder / Hall +5v Supply
SUPRET	J2/2		Hall / Encoder Supply / Voltage Return

Drain
Wire

GUI0025A
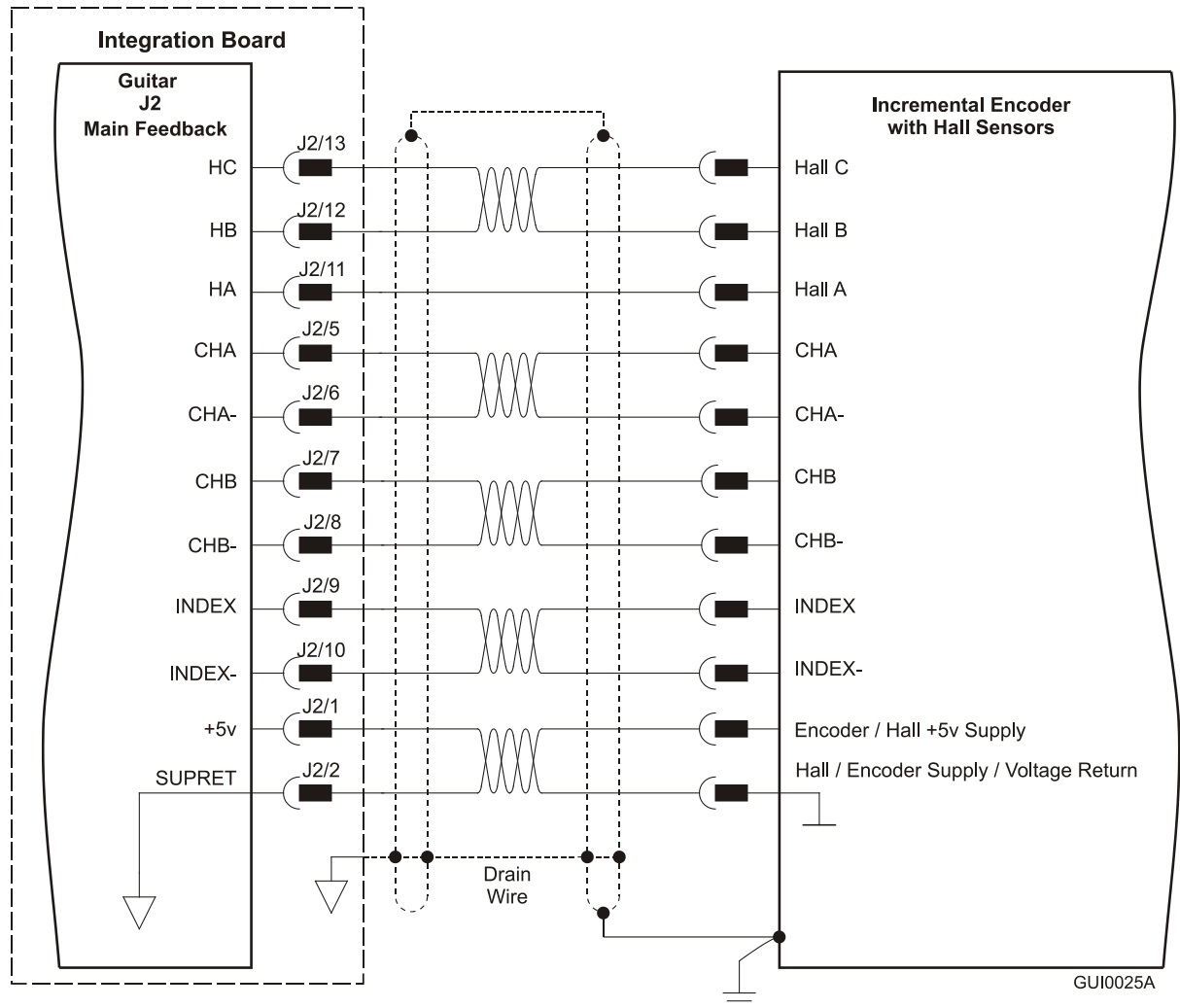
Figure 10: Main Feedback - Incremental Encoder with Digital Hall Sensors Connection
Diagram

GUI0026A
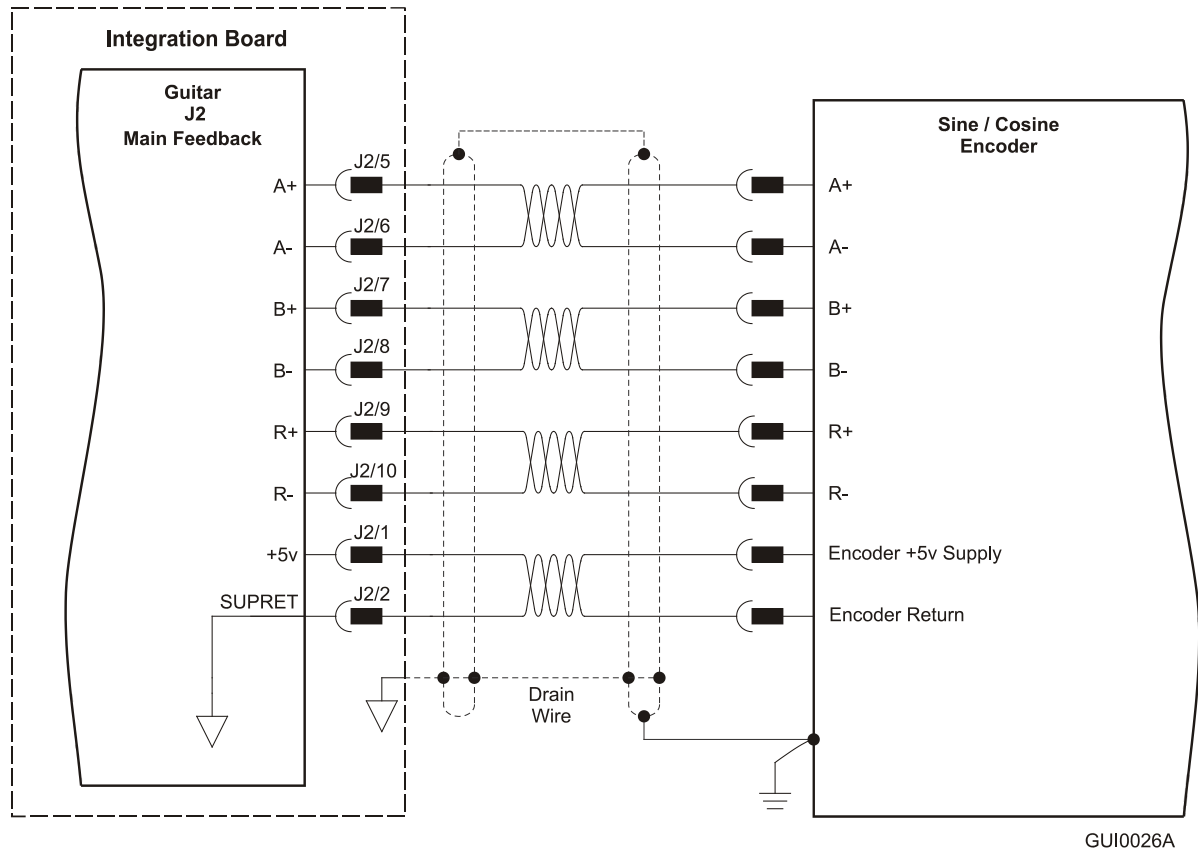
Figure 11: Main Feedback – Interpolated Analog (Sine/Cosine) Encoder Connection Diagram
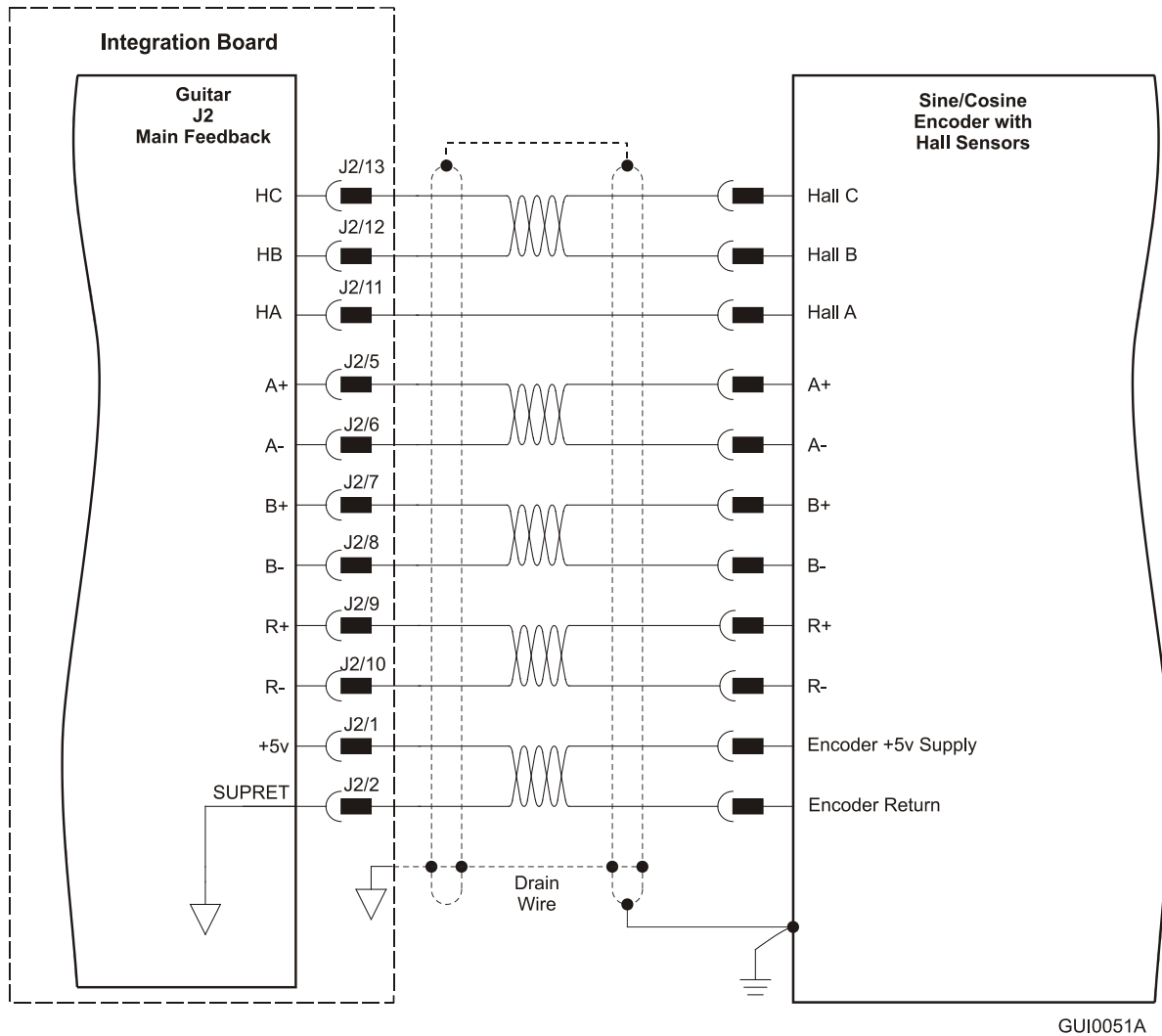
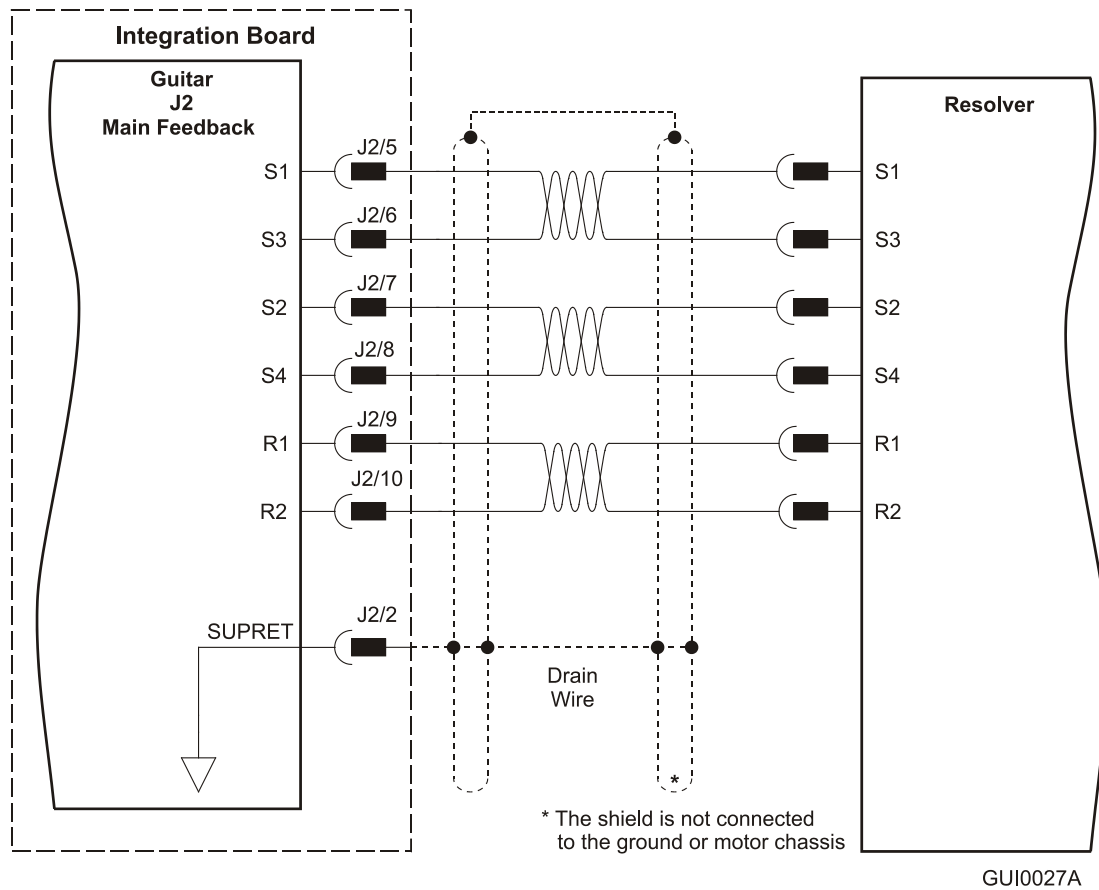**Figure 12: Main Feedback – Interpolated Analog (Sine/Cosine) Encoder with Digital Hall Sensors Connection Diagram**

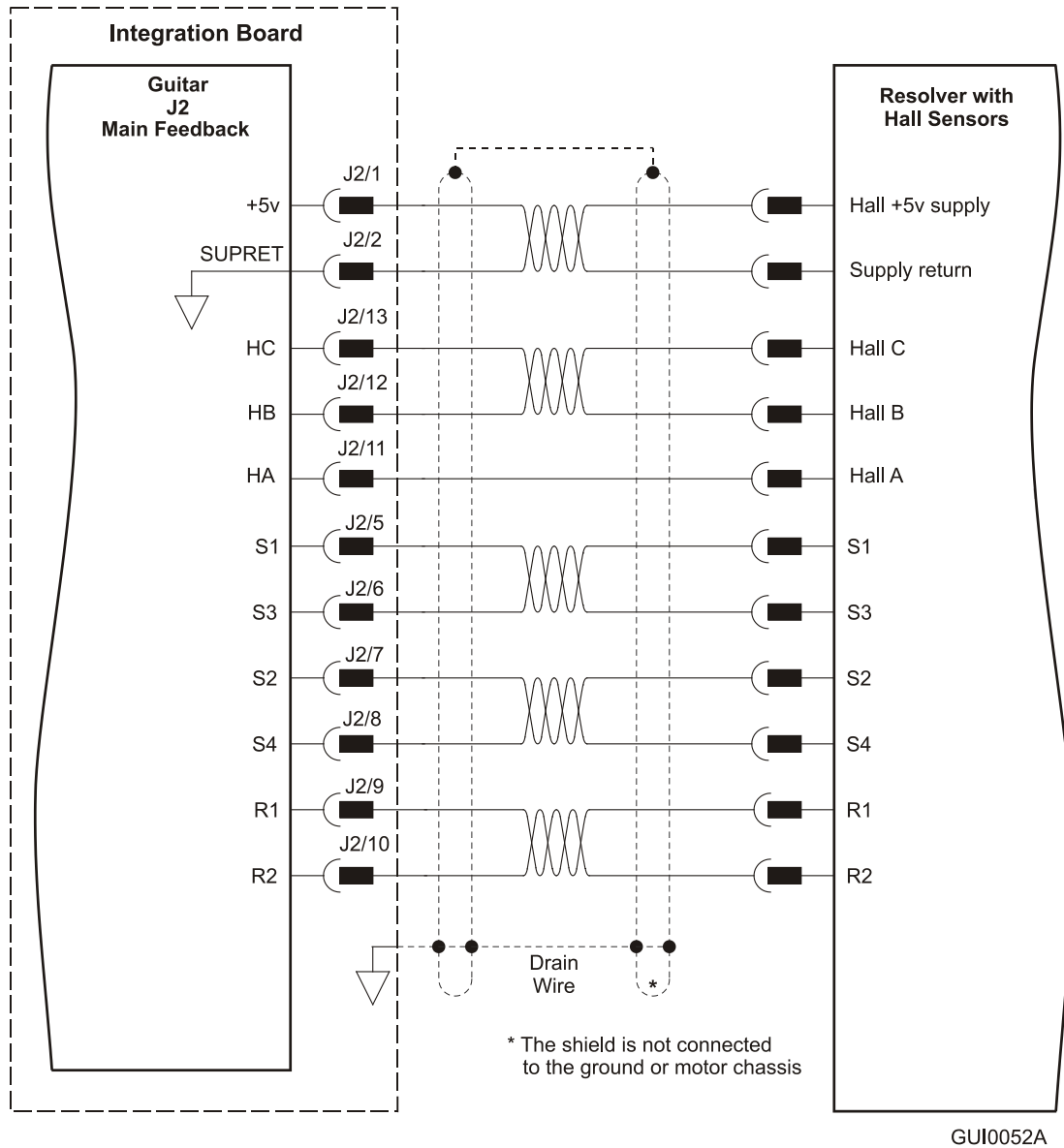**Figure 13: Main Feedback – Resolver Connection Diagram**

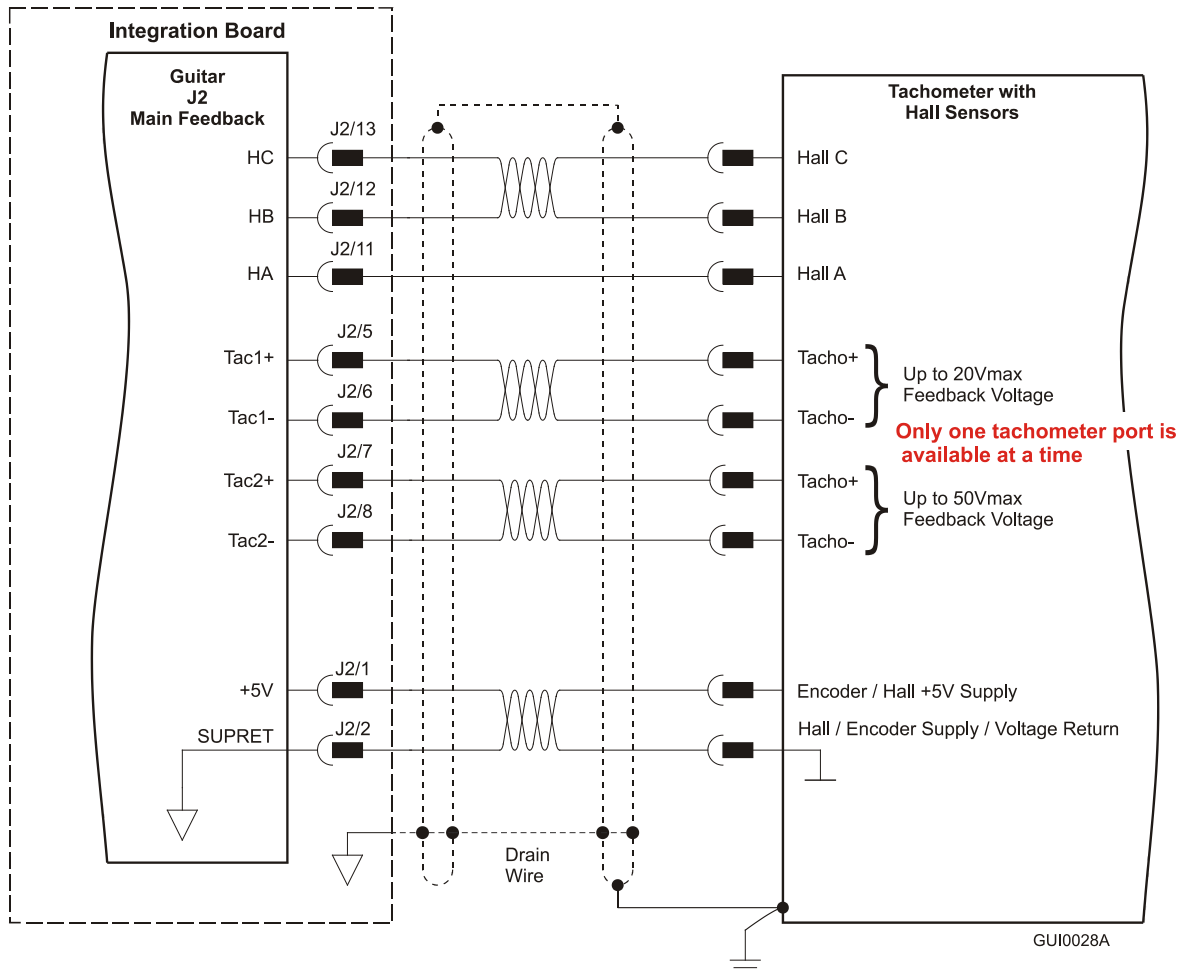**Figure 14: Main Feedback – Resolver and Digital Hall Sensors Connection Diagram**

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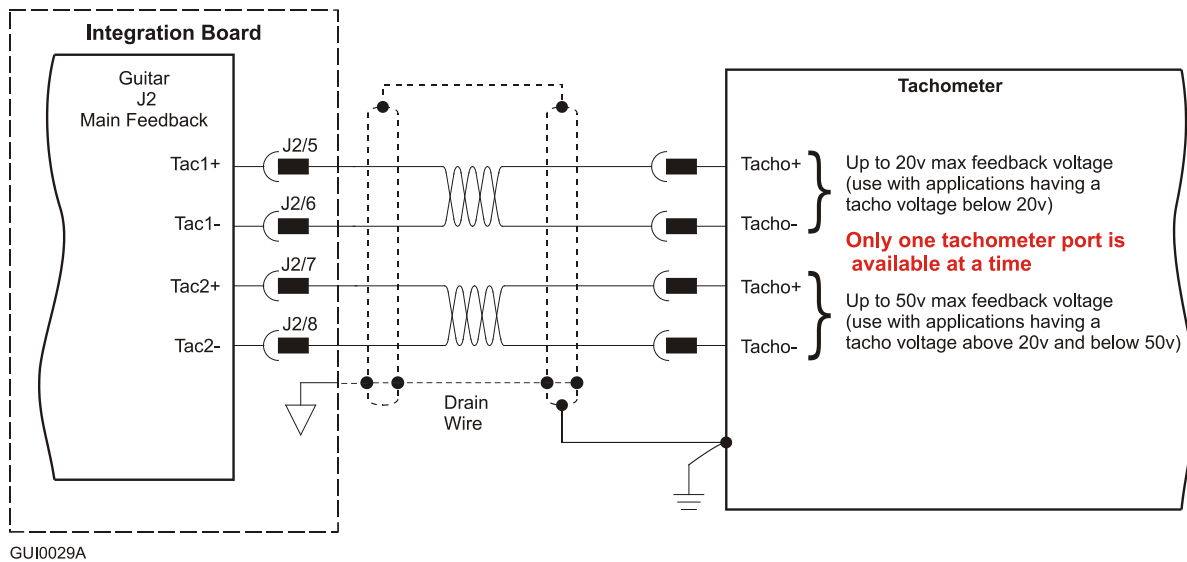

Figure 16: Main Feedback – Tachometer Feedback Connection Diagram for Brush Motors
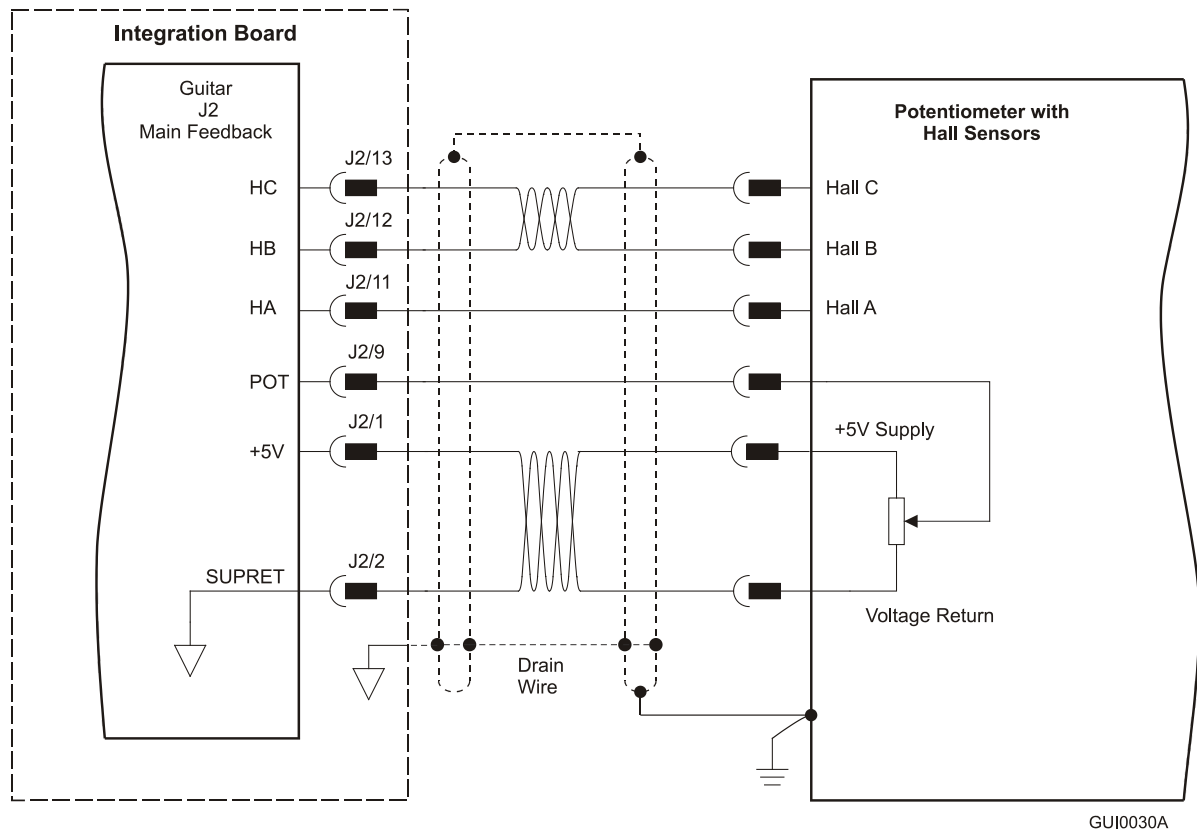
**Figure 17: Main Feedback – Potentiometer Feedback with Digital Hall Sensors
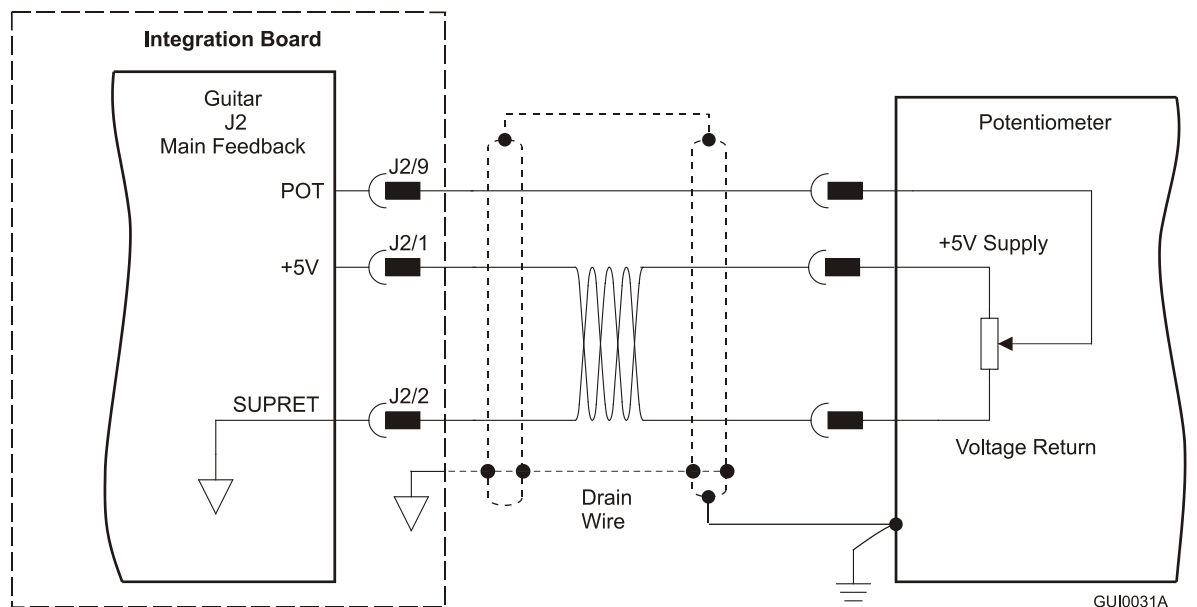Connection Diagram for Brushless Motors**

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

3.10. Auxiliary Feedback

For auxiliary feedback, select one of the following options:

a. **Single-ended emulated encoder outputs**, used to provide emulated encoder signals to another controller or drive. The Emulated Encoder Output Option is only available when using a Resolver, Analog Encoder, Tachometer, Potentiometer or Absolute Encoder as the main feedback device. The absolute model provides differential emulated encoder output.
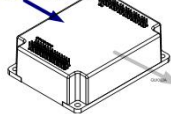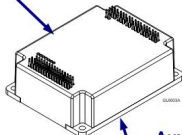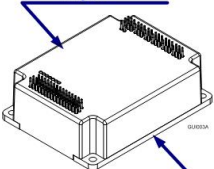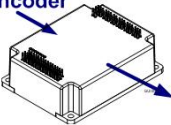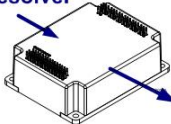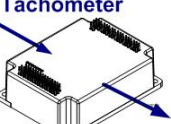
   This option can be used when:

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

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

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

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

3.10.1. Main and Auxiliary Feedback Combinations

The Main Feedback is always used in motion control devices whereas Auxiliary Feedback is often, but not always used. The Auxiliary Feedback connector on the Guitar has three bi-directional pins (CHA, CHB and INDEX). When used in combination with Main Feedback, the Auxiliary Feedback can be set, by software, as follows:

Main Feedback	Auxiliary Feedback		
Software Setting	YA[4] = 4 (Aux. Feedback: output)	YA[4] = 2 (Aux. Feedback: input)	YA[4] = 0 (Aux. Feedback: input)
Incremental Encoder Input	Main Feedback: Incremental Encoder — Aux. Feedback: There is no Aux. Feedback output option when an Incremental Encoder is the main feedback device	Main Feedback: Incremental Encoder or Analog Encoder or Resolver or Tachometer or Potentiometer Input — Aux. Feedback: Single-ended Incremental Encoder Input	Main Feedback: Incremental Encoder or Analog Encoder or Resolver or Tachometer or Potentiometer Input — Aux. Feedback: Single-ended Pulse & Direction Commands
Interpolated Analog (Sine/Cosine) Encoder Input	★ Main Feedback: Analog Encoder — Aux. Feedback: Analog Encoder position data emulated in single-ended, unbuffered Incremental Encoder format		
Resolver Input	✳ Main Feedback: Resolver — Aux. Feedback: Resolver position data emulated in single-ended, unbuffered Incremental Encoder format		
Potentiometer or Tachometer Input	✸ Main Feedback: Potentiometer or Tachometer — Aux. Feedback: Tachometer or Potentiometer position data emulated in single-ended unbuffered incremental encoder format		

Main Feedback	Auxiliary Feedback		
Typical Applications	★ 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. ✴ Tachometer or potentiometer applications where position data is required in the Encoder's quadrature format.	Any application where two feedbacks are used by the drive. The Auxiliary Feedback port serves as an input for the auxiliary incremental encoder. For applications such as Follower, ECAM, or Dual Loop.	Any application where two feedbacks are used by the drive. The Auxiliary Feedback port serves as an input for Pulse & Direction Commands.

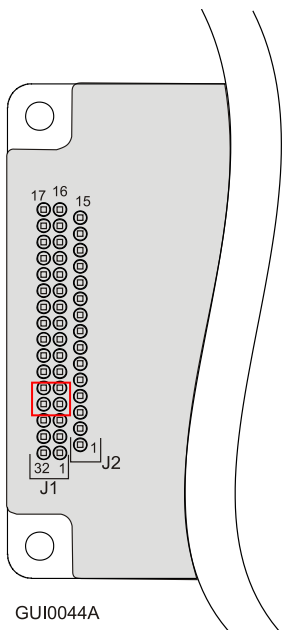### 3.10.2. Auxiliary Feedback: Emulated Encoder Output Option (YA[4]=4)

Pin (J1)	Signal	Function	Pin Positions
28	COMRET	Common return	
29	INDEX	Auxiliary index output	
5	CHBO	Auxiliary Channel B output	
4	CHAO	Auxiliary Channel A output	

Notes:

- The Emulated Encoder Output Option is only available when using a Resolver, Analog Encoder, Tachometer or Potentiometer as the main feedback device.

- The Guitar's Auxiliary Feedback is single-ended. When mounted on an integration board, circuitry can be added to make it differential (Figure 21 (highly recommended)).

GUI0044A

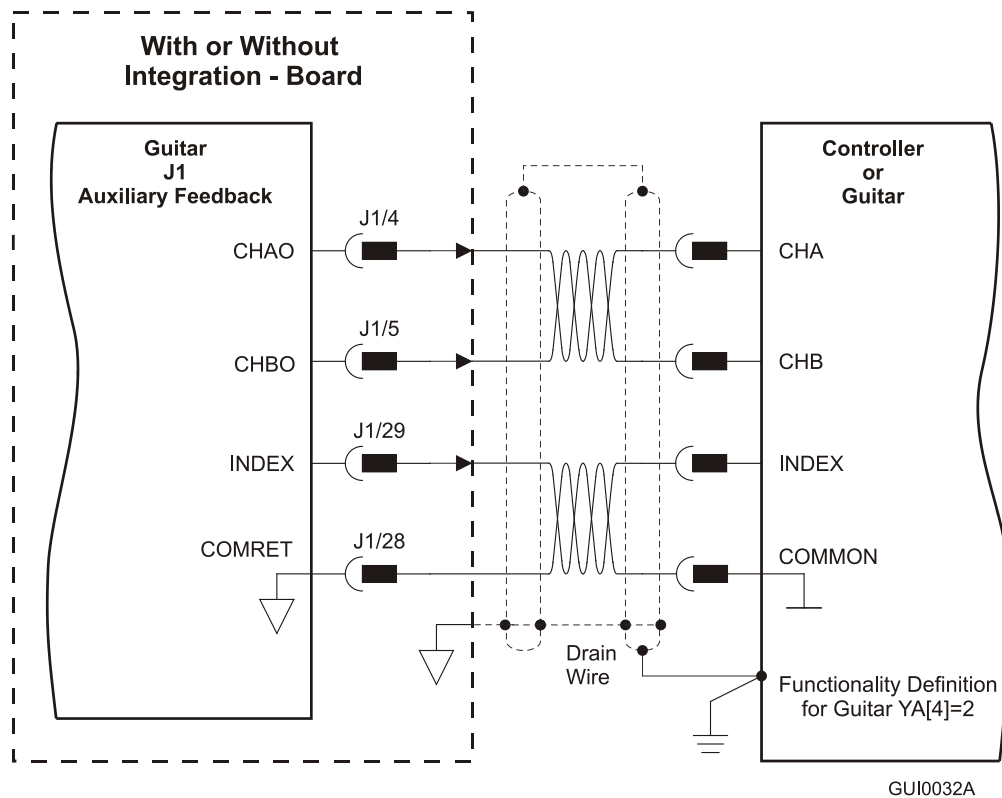**Table 4: Emulated Single-Ended Encoder Output Pin Assignments**

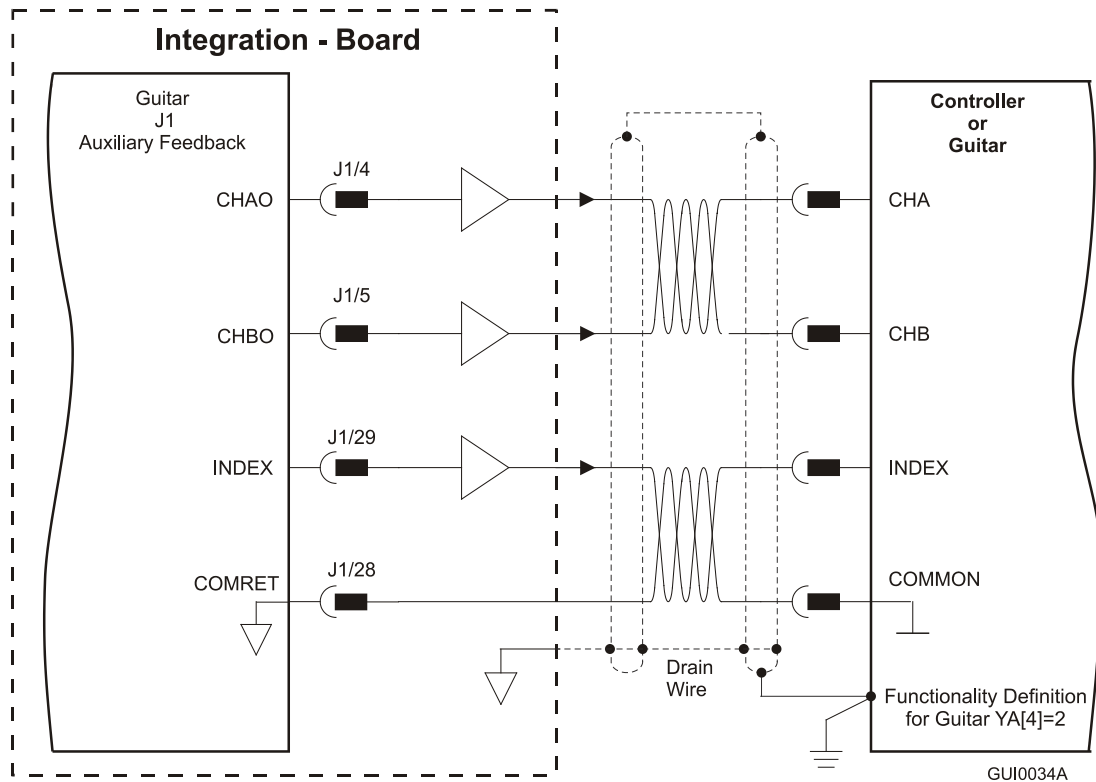**Figure 19: Emulated Encoder Direct Output – Acceptable Connection Diagram**

Figure 20: Emulated Encoder Buffered Output – Recommended Connection Diagram
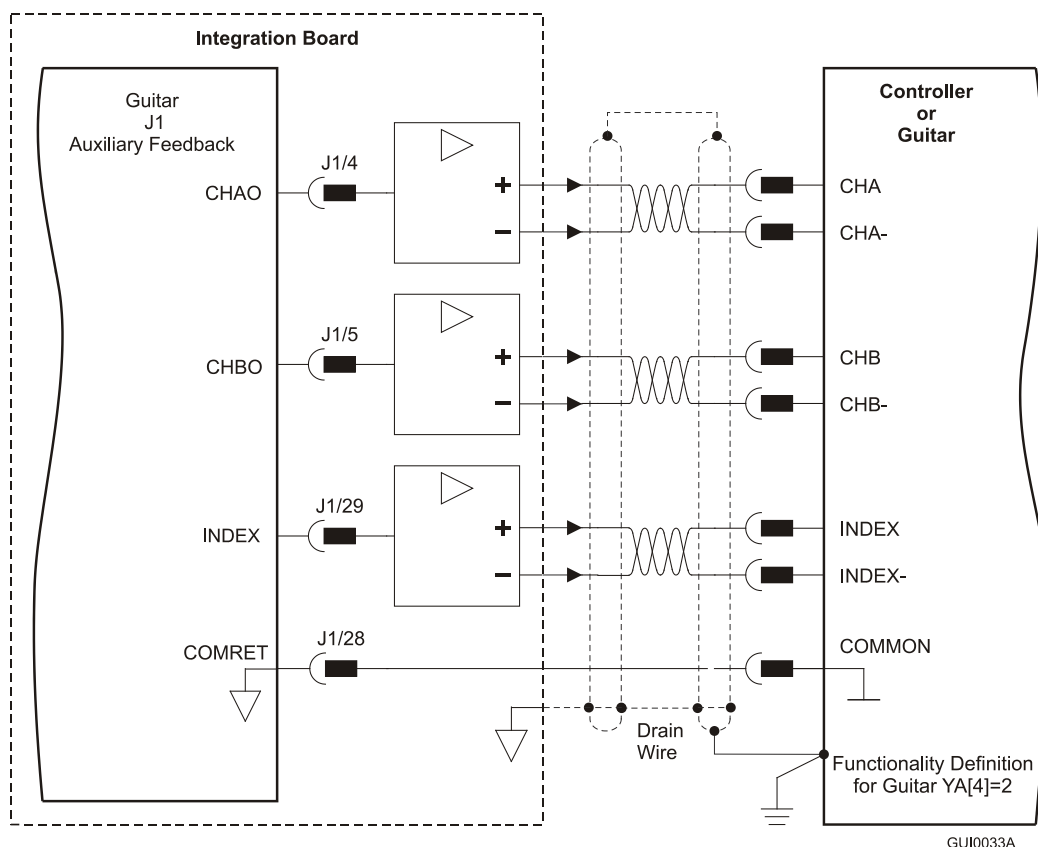
Figure 21: Emulated Encoder Differential Output – Highly Recommended Connection Diagram

3.10.3. Auxiliary Feedback: Single-Ended Encoder Input Option (YA[4]=2)
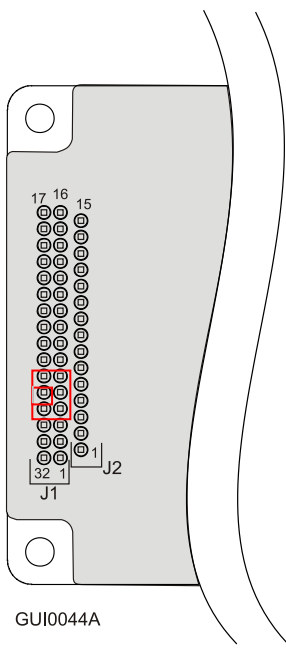
Pin (J1)	Signal	Function	Pin Positions
27	+5 V	Encoder supply voltage	
6	SUPRET	Supply return	
29	INDEX	Auxiliary index input	
5	CHB	Auxiliary channel B input	
4	CHA	Auxiliary channel A input	
Note: The Guitar's Auxiliary Feedback is single-ended. When mounted on an integration board, circuitry can be added to make it differential (Figure 24 (highly recommended)).			

Table 5: Single-Ended Auxiliary Encoder Pin Assignment

Figure 22: Single-ended Auxiliary Encoder Input - Acceptable Connection Diagram
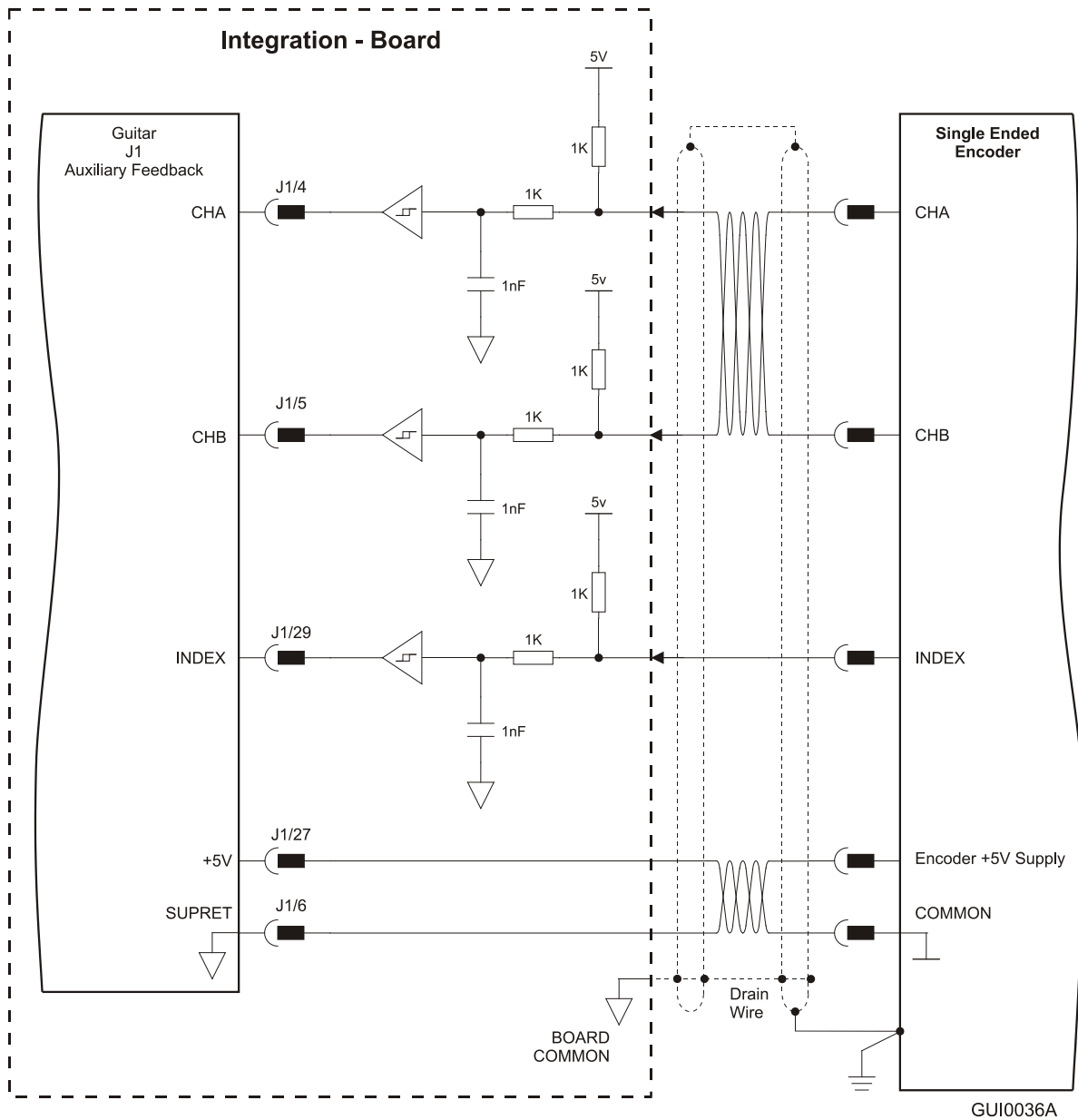
Figure 23: Single-Ended Auxiliary Encoder Input - Recommended Connection Diagram
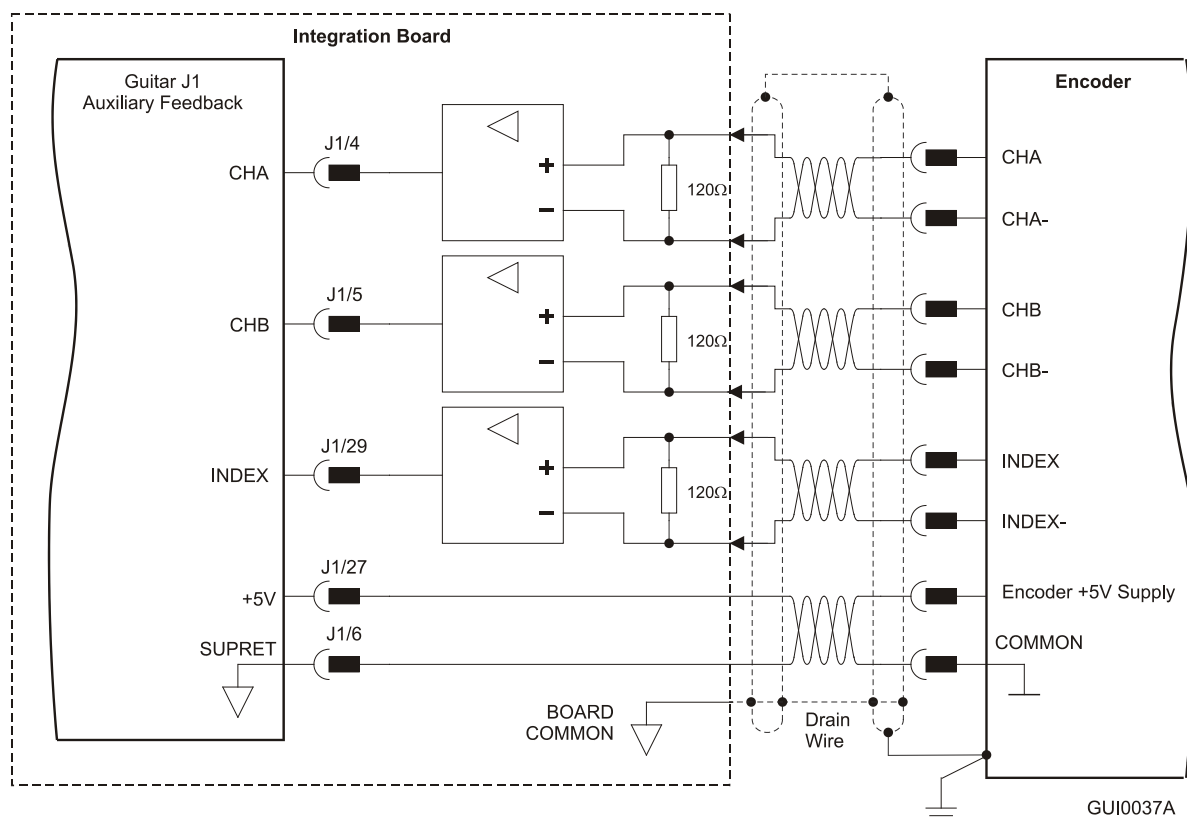
Figure 24: Differential Auxiliary Encoder Input – Highly Recommended Connection Diagram

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

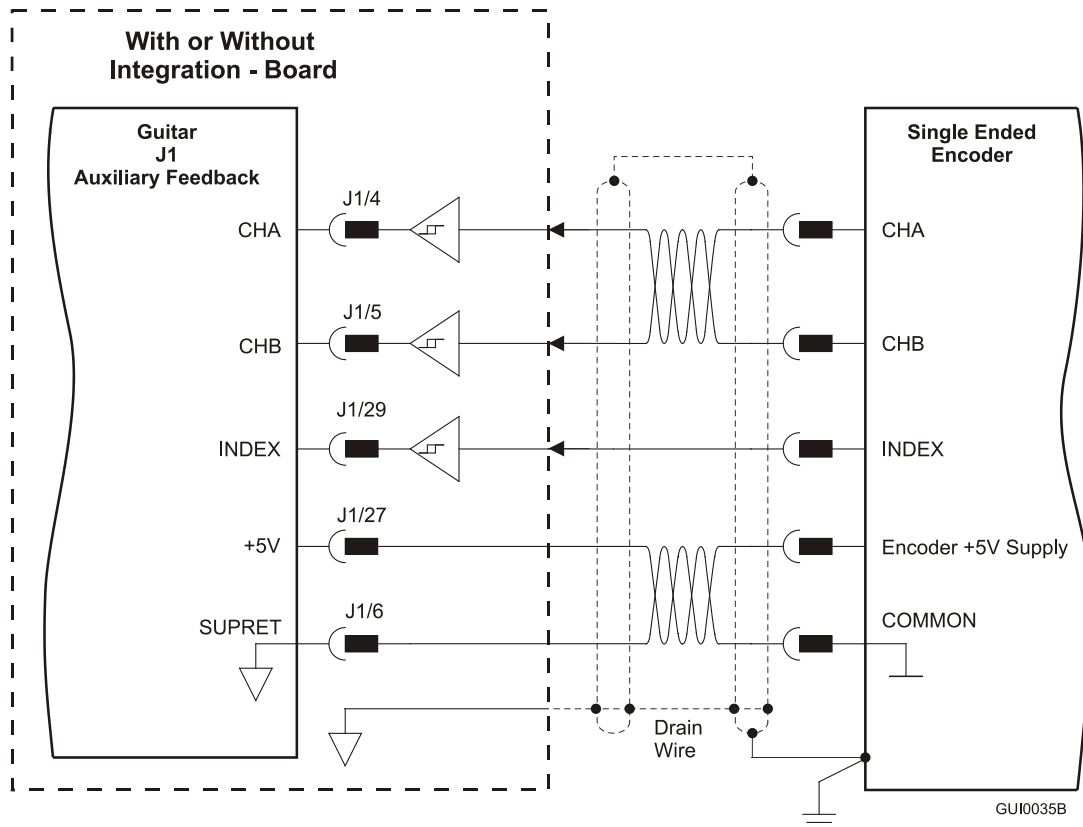| Pin (J1)	Signal	Function	Pin Positions
28	COMRET	Common return	
5	DIR/CHB	Direction input (push/pull 5 V or open collector)	
4	PULS/CHA	Pulse input (push/pull 5 V or open collector)	
Note: The Guitar's Auxiliary Feedback is single-ended. When mounted on an integration board, circuitry can be added to make it differential (Figure 27 (highly recommended)).			

Table 6: Pulse-and-Direction Pin Assignments

Figure 25: Pulse-and-Direction Auxiliary Encoder Input – Direct Connection Diagram

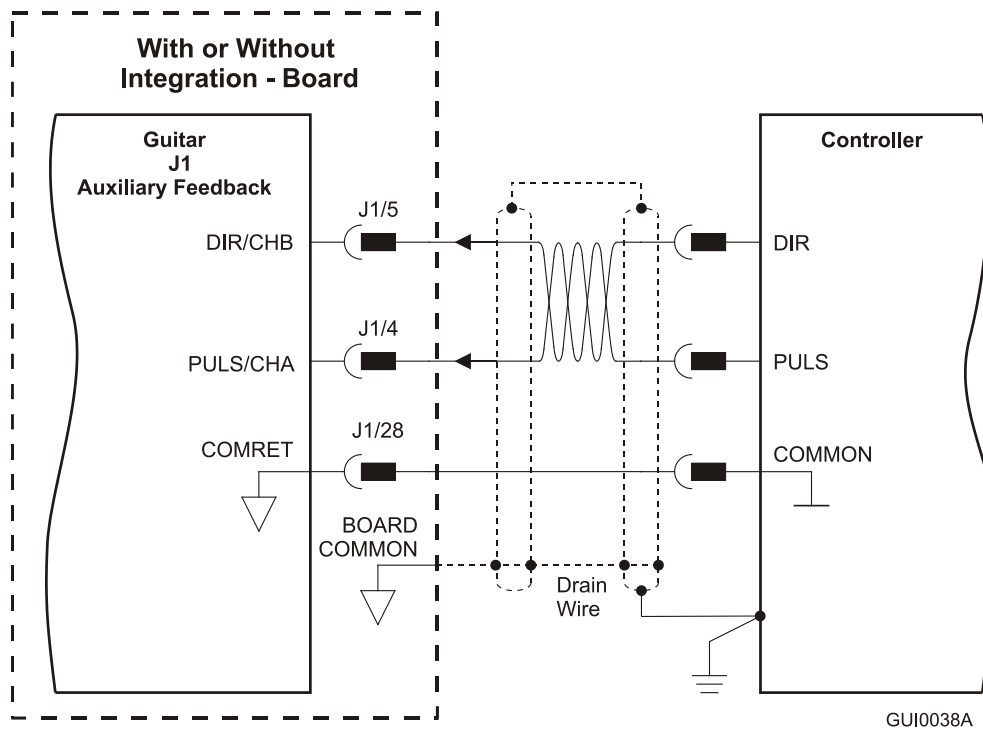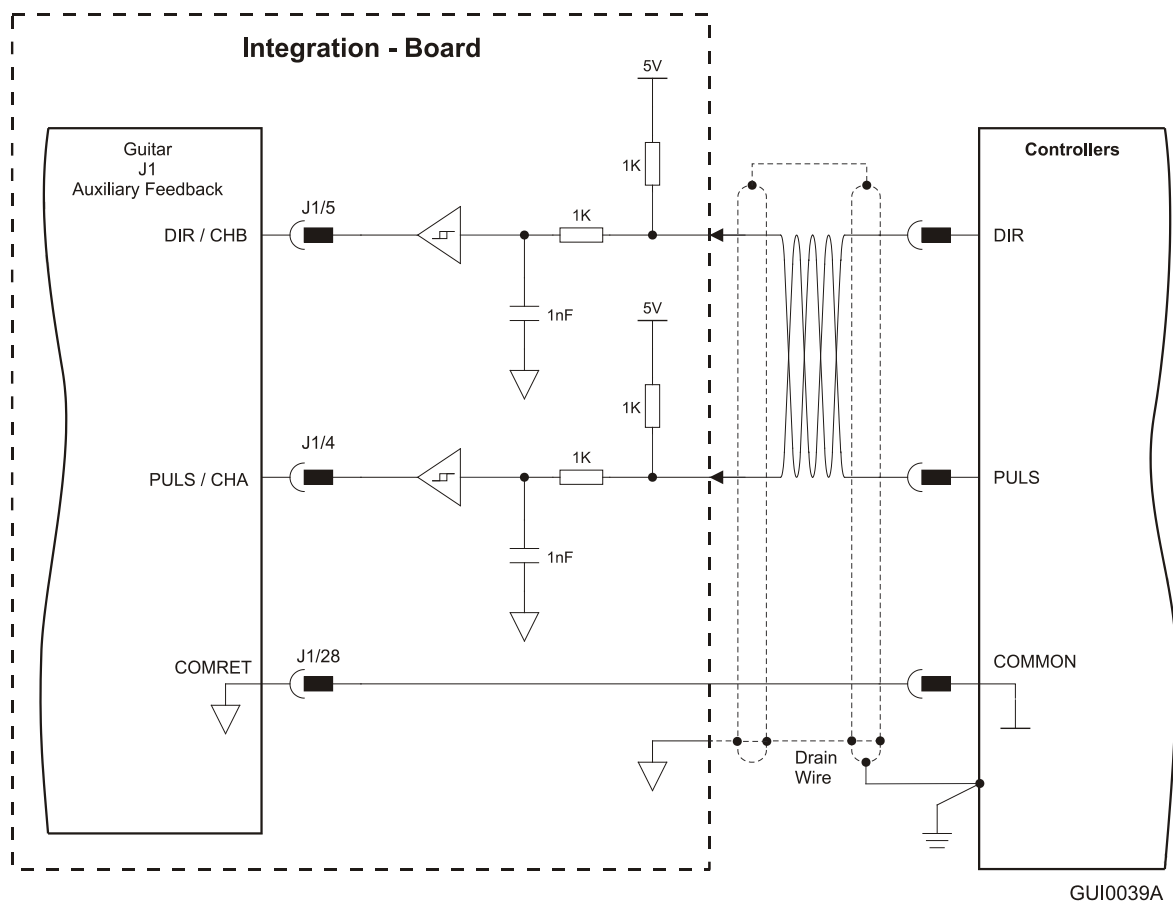**Figure 26: Pulse-and-Direction Auxiliary Encoder Input – Buffered Connection Diagram**
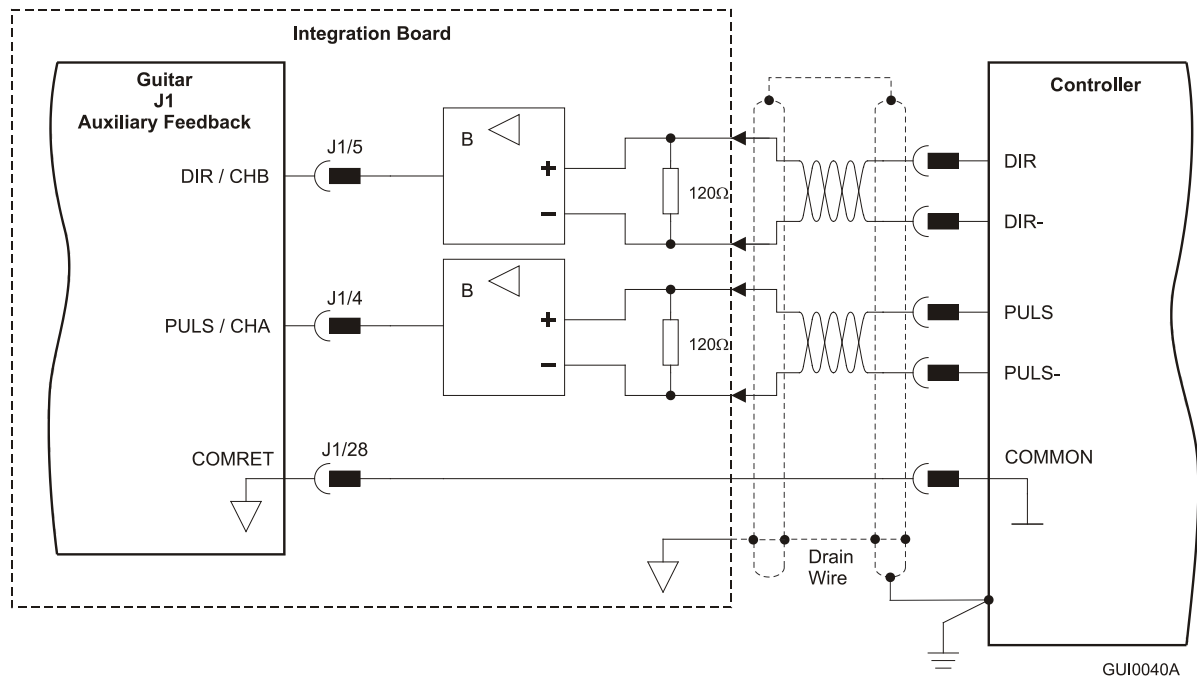
Figure 27: Pulse-and-Direction Auxiliary Encoder Input – Differential Connection Diagram, Highly Recommended

3.11. I/Os

The Guitar has 6 Digital Inputs, 4 Digital Outputs and 1 Analog Input.

I/O	J1	J2	Total
Digital Input	6	-	6
Digital Output	4	-	2
Analog Input	-	1	1

3.11.1. Digital Input

Each of the pins below can function as an independent input.
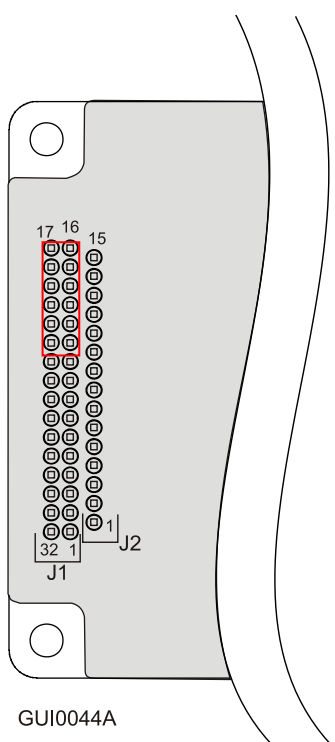
Pin (J1)	Signal	Function	Pin Positions
11	IN1	Programmable input 1 (general purpose, RLS, FLS, INH)	
12	IN2	Programmable input 2 (general purpose, RLS, FLS, INH)	
13	IN3	Programmable input 3 (general purpose, RLS, FLS, INH)	
14	IN4	Programmable input 4 (general purpose, RLS, FLS, INH)	
15	IN5	Hi-Speed Programmable input 5 (event capture, Main Home, general purpose, RLS, FLS, INH)	
16	IN6	Hi-Speed Programmable input 6 (event capture, Auxiliary Home, general purpose, RLS, FLS, INH)	
17	INRET6	Programmable input 6 return	
18	INRET5	Programmable input 5 return	
19	INRET4	Programmable input 4 return	
20	INRET3	Programmable input 3 return	
21	INRET2	Programmable input 2 return	
22	INRET1	Programmable input 1 return	

Table 7: Digital Input Pin Assignments
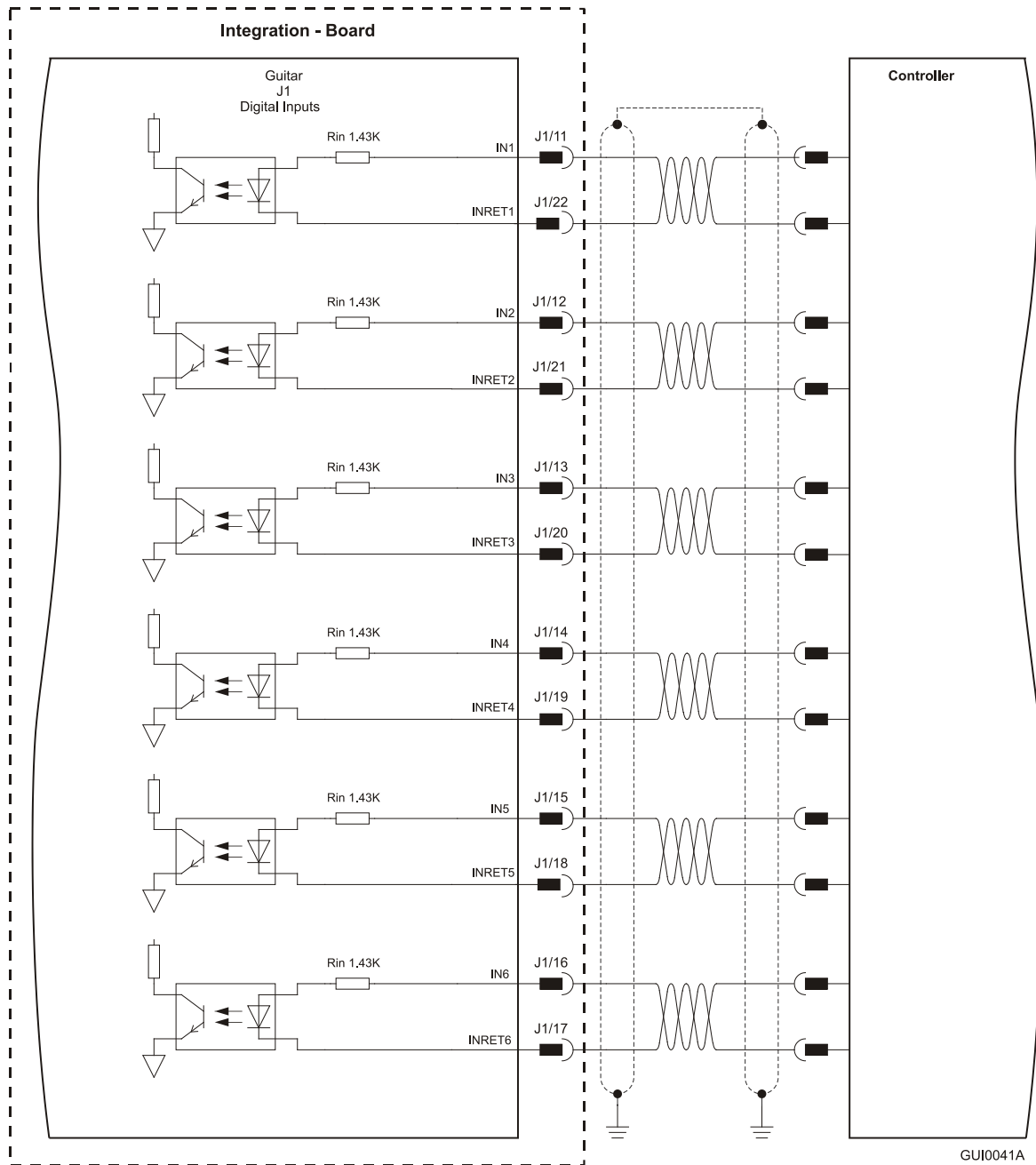
Figure 28: Digital Input Connection Diagram

3.11.2.   Digital Output
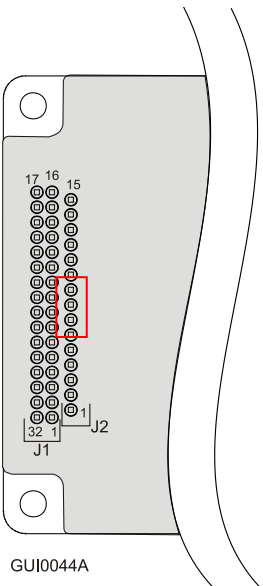
Pin (J1)	Signal	Function	Pin Positions
7	OUT1	High-Speed Programmable digital output 1	
8	OUT2	Programmable digital output 2	
9	OUT3	Programmable digital output 3	
10	OUT4	Programmable digital output 4	
26	OUTRET1	Programmable digital output 1 return	
25	OUTRET2	Programmable digital output 2 return	
24	OUTRET3	Programmable digital output 3 return	
23	OUTRET4	Programmable digital output 4 return	

Table 8: Digital Output Pin Assignment
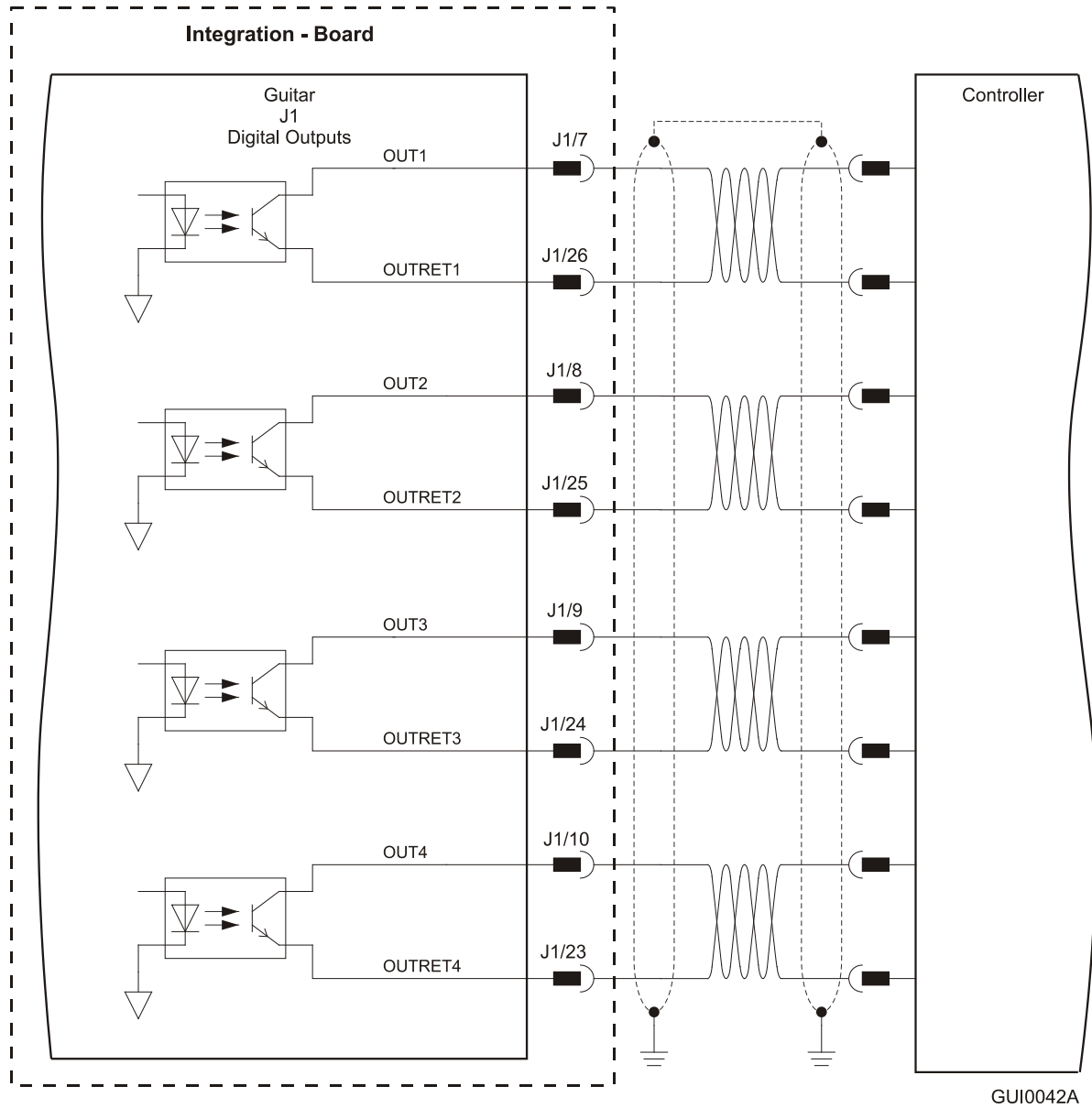
Figure 29: Digital Output Connection Diagram

3.11.3. Analog Input
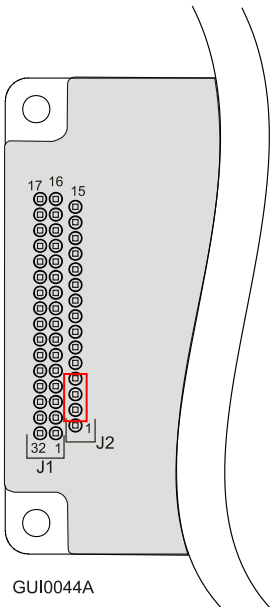
Pin (J2)	Signal	Function	Pin Positions
3	ANLIN1+	Analog input 1+	
4	ANLIN1-	Analog input 1-	
2	ANLRET	Analog ground	

Table 9: Analog Input Pin Assignments
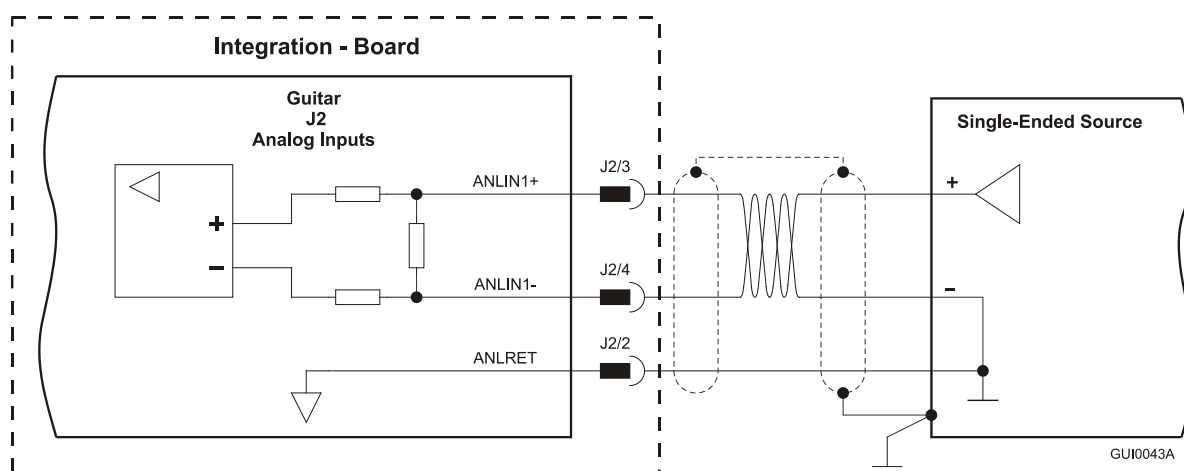
Figure 30: Analog Input with Single-Ended Source

3.12. Communications

The communication interface may differ according to the user's hardware. The Guitar 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 Guitar to a serial interface on the PC. The interface is selected and set up in the Composer software.

In order to benefit from **CAN** communication, the user must have an understanding of the basic programming and timing issues of a CAN network.

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

3.12.1.   RS-232 Communication

Notes for connecting the RS-232 communication cable:

• Connect the shield to the ground of the host (PC). Usually, this connection is soldered internally inside the connector at the PC end. You can use the drain wire to facilitate connection.

• The RS-232 communication port is **non-isolated**.

• Ensure that the shield of the cable is connected to the shield of the connector used for RS-232 communications. The drain wire can be used to facilitate the connection.
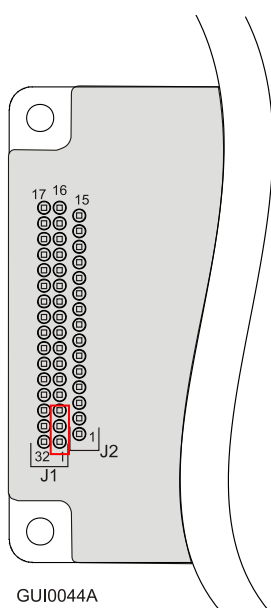
Pin (J1)	Signal	Function	Pin Location
1	RS232_Rx	RS-232 receive	
2	RS232_Tx	RS-232 transmit	
3	RS232_COMRET	Communication return	

Table 10: RS-232 Pin Assignments
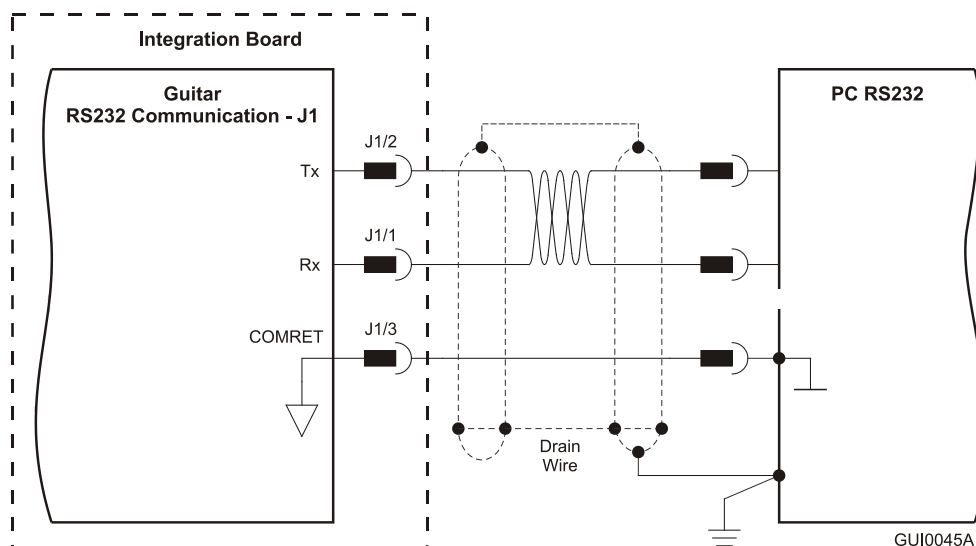
Figure 31: RS-232 Connection Diagram

3.12.2.   CAN Communication

Notes for connecting the CAN communication cable:

- Connect the shield to the ground of the host (PC). Usually, this connection is soldered internally inside the connector at the PC end. You can use the drain wire to facilitate connection.

- Ensure that the shield of the cable is connected to the shield of the connector used for communications. The drain wire can be used to facilitate the connection.

- Make sure to have a 120-Ω resistor termination at each of the two ends of the network cable.

- The Guitar's CAN port is **non-isolated**.
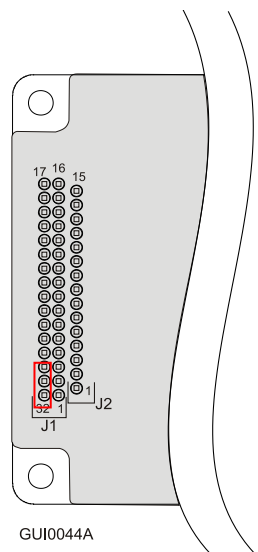
Pin (J1)	Signal	Function	Pin Positions
30	CAN_GND	CAN ground	
31	CAN_L	CAN_L busline (dominant low)	
32	CAN_H	CAN_H busline (dominant high)	

Table 11: CAN - Pin Assignments

GU0046A
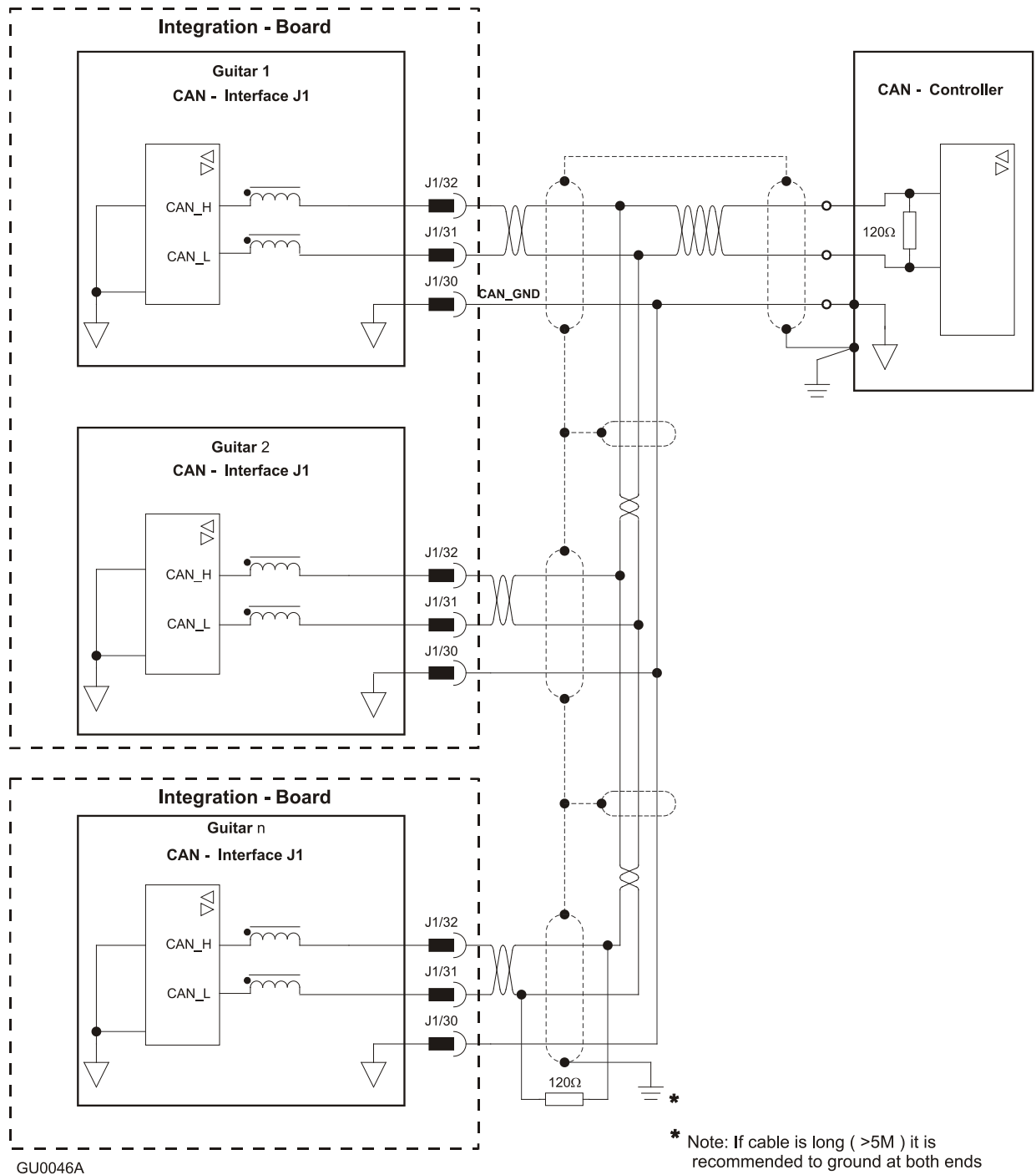
Figure 32: CAN Network Diagram

Caution:

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

3.13. Powering Up

After the Guitar is connected to its device, it is ready to be powered up.

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

3.14. Initializing the System

After the Guitar 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*.

3.15. Heat Dissipation

The best way to dissipate heat from the Guitar is to mount it so that its heatsink faces up. For best results leave approximately 10 mm of space between the Guitar's heatsink and any other assembly.

3.15.1.   Guitar Thermal Data

- Heat dissipation capability (θ): Approximately 8 °C/W.

- Thermal time constant: Approximately 360 seconds (thermal time constant means that the Guitar will reach 2/3 of its final temperature after 6 minutes).

- Shut-off temperature: 86 °C to 88 °C (measured on the heatsink)

3.15.2.   Heat Dissipation Data

Heat Dissipation is shown in graphically below:

Guitar 100V Power Dissipation

Guitar 200V Power Dissipation
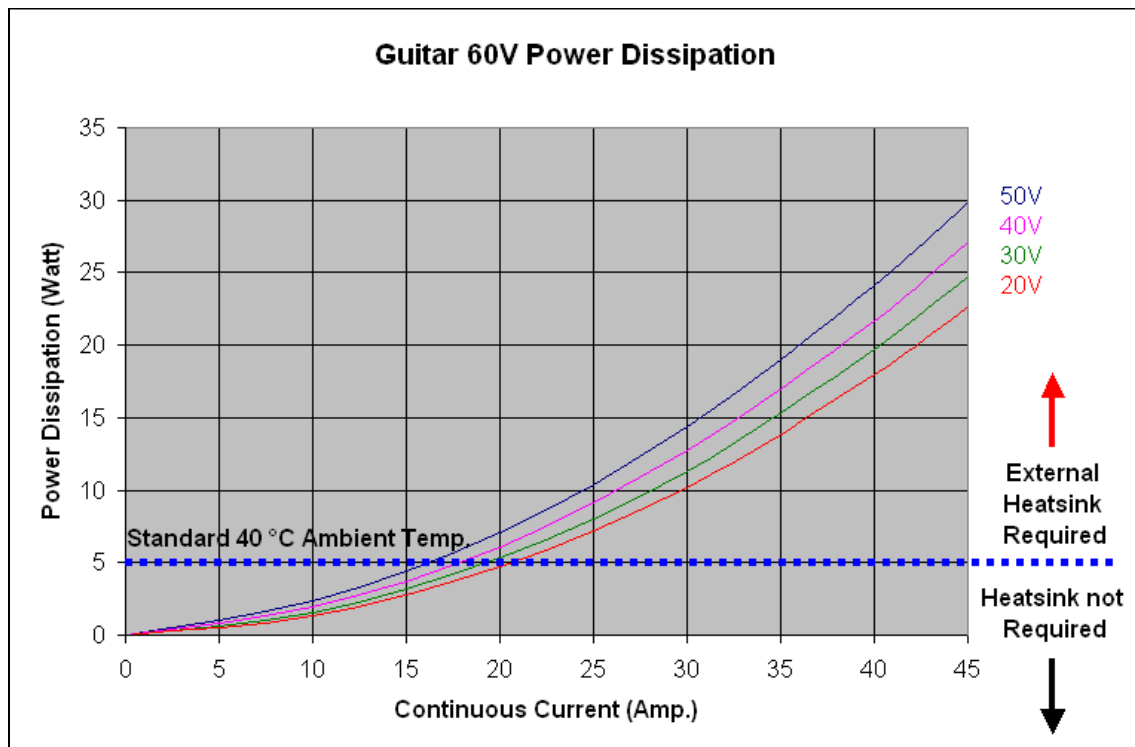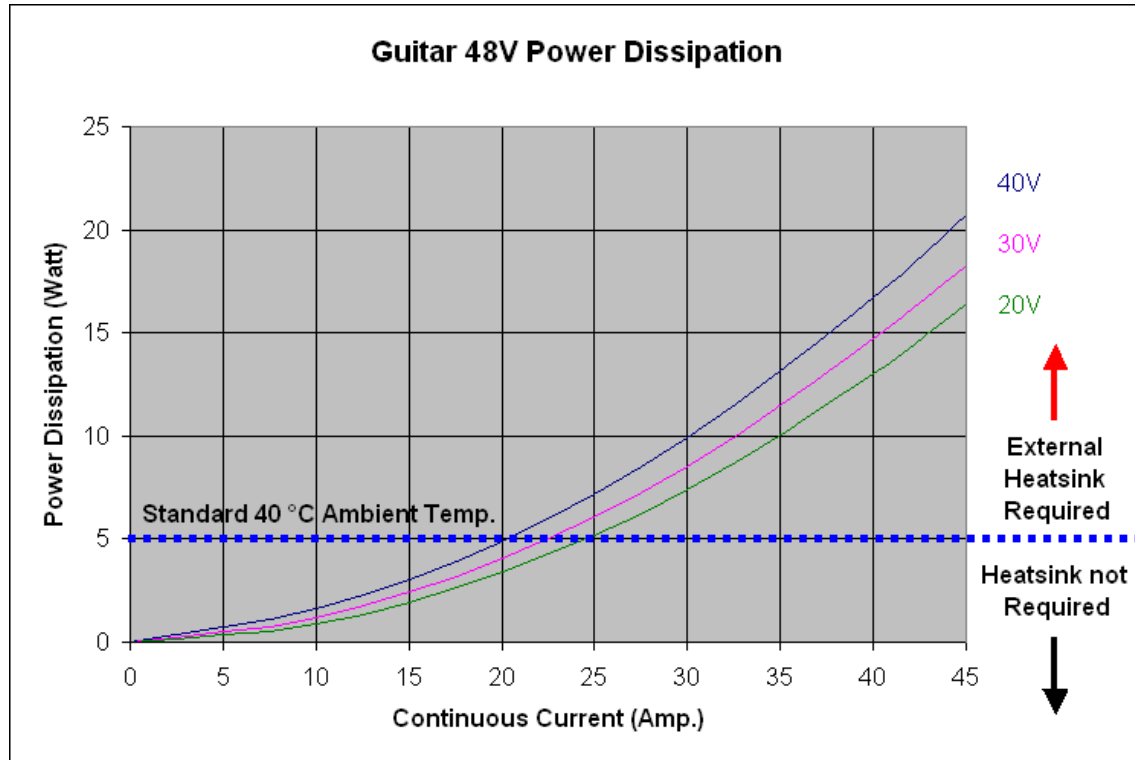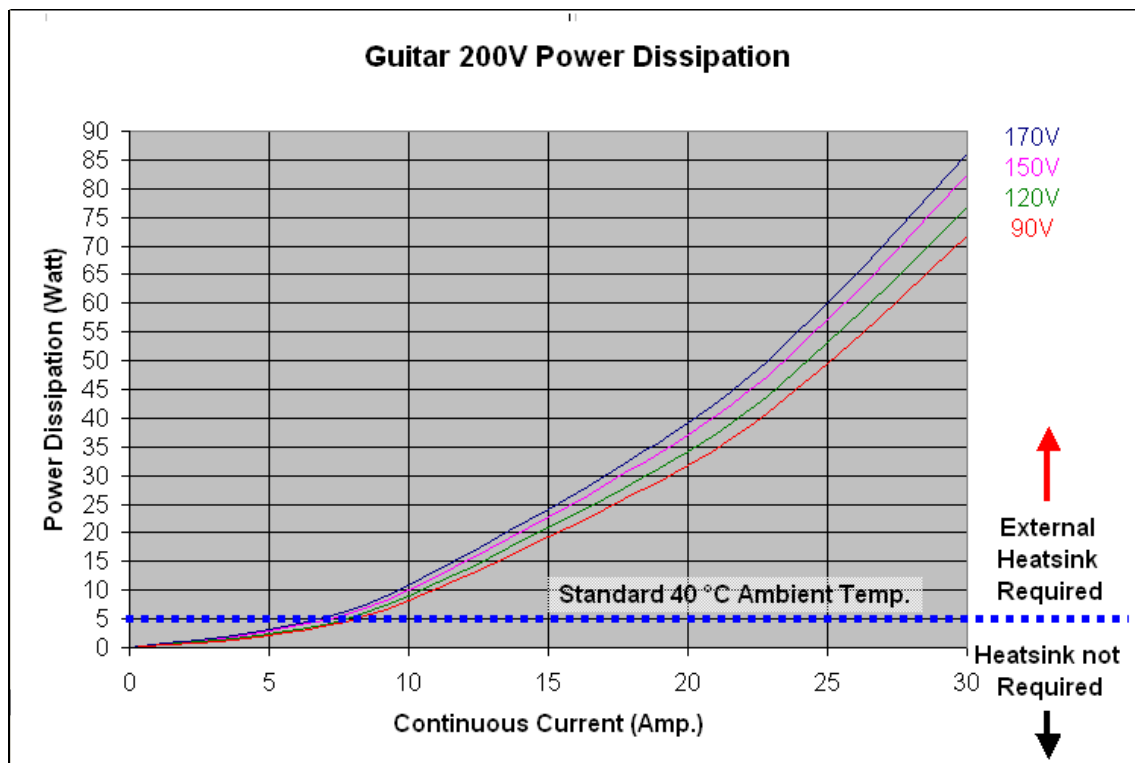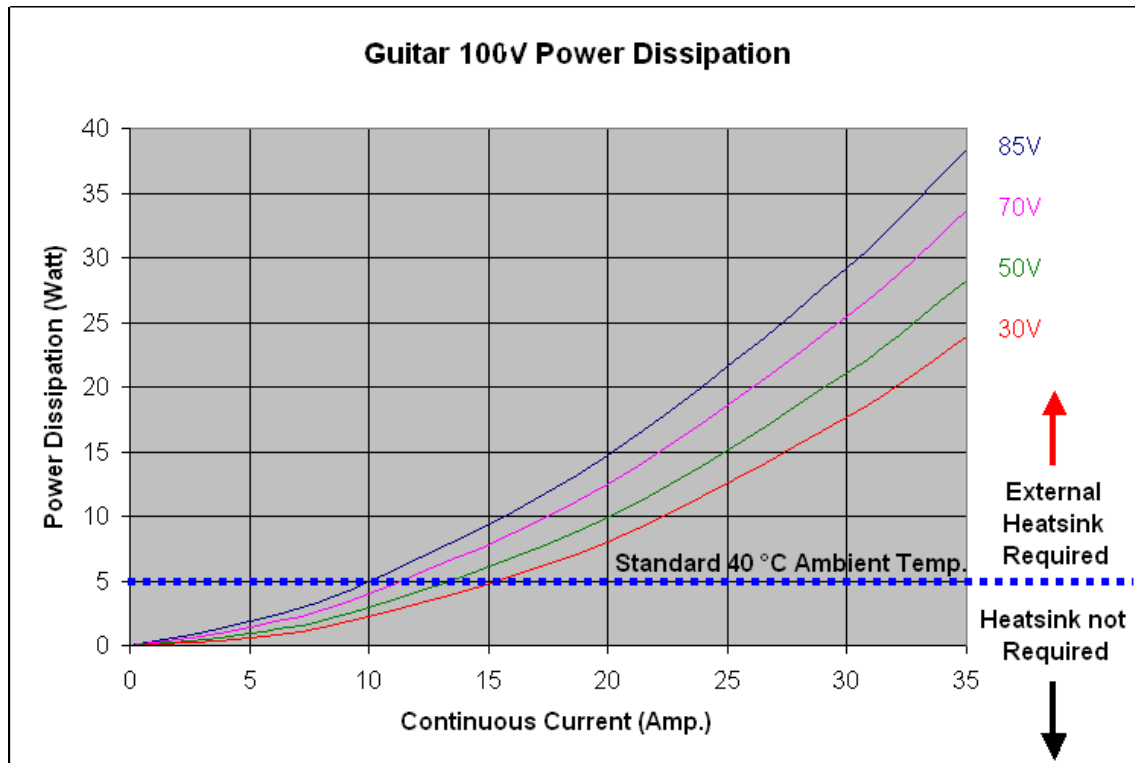
3.15.3. How to Use the Charts

The charts above are based upon theoretical worst-case conditions. Actual test results show 30% to 50% better power dissipation.

To determine if your application needs a heatsink:

1. Allow maximum heatsink temperature to be 80 °C or less.

2. Determine the ambient operating temperature of the Guitar.

3. Calculate the allowable temperature increase as follows:

    ▪ for an ambient temperature of 40 °C , ΔT= 80 °C – 40 °C = 40 °C

4. Use the chart to find the actual dissipation power of the drive. Follow the voltage curve to the desired output current and then find the dissipated power.

5. If the dissipated power is below 5 W the Guitar will need no additional cooling.

Note: The chart above shows that no heatsink is needed when the heatsink temperature is 80 °C, ambient temperature is 40 °C and heat dissipated is 5 Watts.

3.16. Evaluation Board and Cable Kit

A circuit board is available for evaluating the Guitar. It comes with standard terminal blocks for power connections and D-Sub plugs/sockets for signals connections. The Evaluation Board is provided with a cable kit.
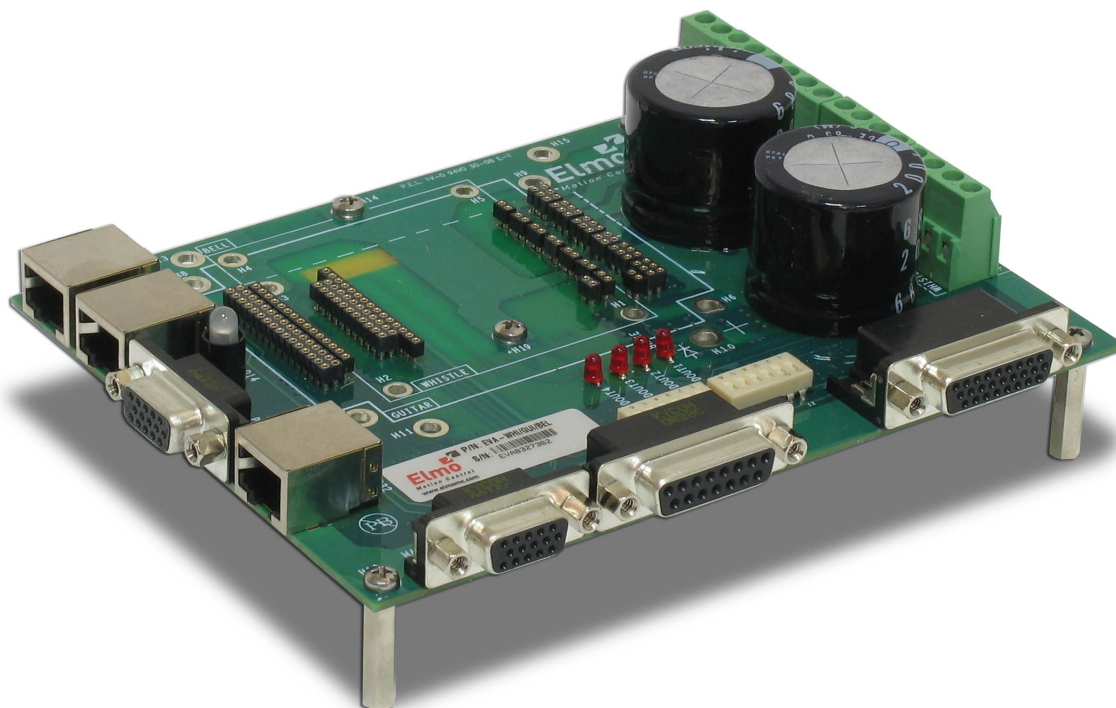
Figure 33: The Evaluation Board (can be ordered separately)

Evaluation Board **Evaluation Board User Manual**	**Catalog Number**: EVA-WHI/GUI/BEL MAN-EVLBRD-WHI_BEL_GUI-UG.pdf (available on our website)

Chapter 4:   Technical Specifications

This chapter provides detailed technical information regarding the Guitar. 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 Guitar'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 Control Modes

- PTP, PT, PVT, ECAM, Follower, Dual Loop, Current Follower

- Fast event capturing inputs

- Fast output compare (OC)

- Motion Commands: Analog current and velocity, pulse-width modulation (PWM) current and velocity, digital (SW) and Pulse and Direction

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 – "Composer"

- 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

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

  - Internal Interpolation - up to x4096
  - Automatic Correction of amplitude mismatch, phase mismatch, signal offset
  - Emulated encoder outputs, single-ended, unbuffered of the Analog encoder

- Analog Hall Sensor

- Resolver

  - Programmable 10 to 15 bit resolution
  - Up to 512 revolutions per second (RPS)
  - Emulated encoder outputs, single-ended, unbuffered of the Resolver

- Auxiliary Encoder inputs (ECAM, follower, etc.) single-ended, unbuffered

- Tachometer & Potentiometer

- The Guitar can provide power (5 V, 2x200 mA max) for Encoders, Resolver or Halls.

4.1.6.   Input/Output

- One **Analog Input** – up to 14-bit resolution

- Six separate programmable **Digital Inputs**, optically isolated (two of which are fast event capture inputs).

  - Inhibit/Enable motion
  - Software and analog reference stop
  - Motion limit switches
  - Begin on input
  - Abort motion
  - Homing
  - General-purpose

- Four separate programmable **Digital Outputs**, optically isolated (open collector) one with fast output compare (OC):

  - Brake Control
  - Amplifier fault indication
  - General-purpose
  - Servo enable indication

- Pulse and Direction inputs (single-ended)

- PWM current command output for torque and velocity

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
  - Over-heating

    - Continuous temperature measurement. Temperature can be read on the fly; a warning can be initiated x degrees before temperature disable is activated.
  - Over/Under voltage
  - Loss of feedback
  - Following error
  - Current limits

4.1.8. Accessories

- External heatsink (TBD).

- Evaluation Board. See Section 3.16 for a picture and more details. Catalog number: EVA-WHI/GUI/BEL

- Cable Kit. See Section 3.16 for more details. Catalog number: CBL-EVAUNIKIT01

4.1.9. Status Indication

- Output for a bi-color LED

4.1.10. Automatic Procedures

- Commutation alignment

- Phase sequencing

- Current loop offset adjustment

- Current loop gain tuning

- Current gain scheduling

- Velocity loop offset adjustment

- Velocity gain tuning

- Velocity gain scheduling

- Position gain tuning

4.2.　Guitar Dimensions

61±0.5mm

29.46±0.5mm

24.50±0.5

∅3.50x4

80±0.5mm

GUI0004B
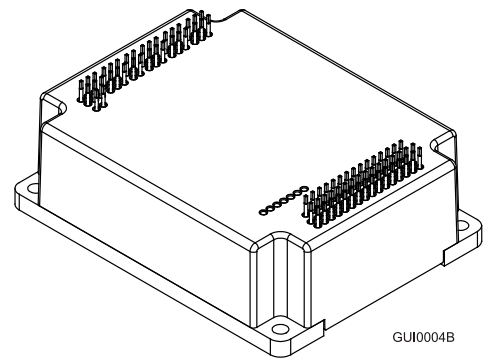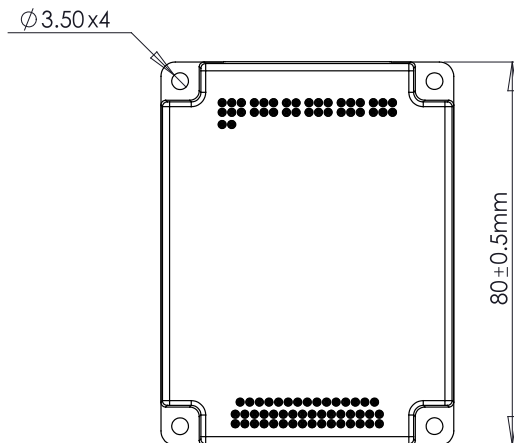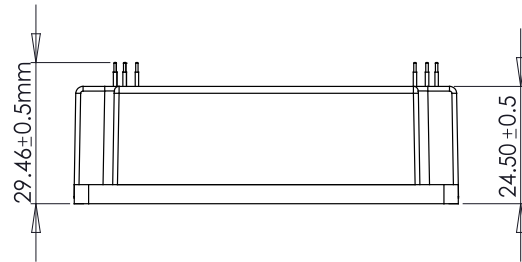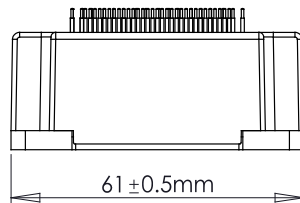
4.3. Power Ratings up to 100 V Models

Feature	Units	35/48	20/60	25/60	35/60	20/100	25/100	50/100	R45/48	R75/48*	R45/60	R75/60*	R35/100
Minimum supply voltage	VDC	11	14			23			11		14		23
Nominal supply voltage	VDC	42	50			85			42		50		85
Maximum supply voltage	VDC	48	59			95			48		59		95
Maximum auxiliary supply voltage	VDC	48	59			95			48		59		95
Maximum continuous power output	W	1300	960	1200	1700	1600	2000	4000	1700	3000	2200	3700	2800
Efficiency at rated power (at nominal conditions)	%	> 97											
Maximum output voltage		97% of DC bus voltage at f=22 kHz											
Amplitude sinusoidal/DC continuous current	A	35	20	25	35	20	25	50	45	75	45	75	35
Sinusoidal continuous RMS current limit (Ic)	A	25	14.1	17.7	25	14.1	17.7	35.3	31.8	53	31.8	53	24.8
Peak current limit	A	2 x Ic							No peak				
Weight	g (oz)	165 g (5.8 oz)											
Dimensions	mm (in)	80 x 61 x 24.5 (3.15" x 2.4" x 0.965")											
Digital in/Digital out/ Analog in		6/4/1											
Mounting method		PCB mount											

Note:

* **Models with power rating R75/48, and R75/60, are purchased without a plastic casing.**

4.4. Power Ratings for 200 V Models

Feature	Units	3/200	6/200	10/200	17/200	20/200	R30/200
Minimum supply voltage	VDC	46					
Nominal supply voltage	VDC	170					
Maximum supply voltage	VDC	195					
Maximum auxiliary supply voltage	VDC	195					
Maximum continuous power output	W	480	960	1600	2700	3200	4800
Efficiency at rated power (at nominal conditions)	%	> 97					
Maximum output voltage		97% of DC bus voltage at f=22 kHz					
Amplitude sinusoidal/DC continuous current	A	3	6	10	17	20	30
Sinusoidal continuous RMS current limit (Ic)	A	2.12	4.2	7	12	14.1	21.2
Peak current limit	A	2 x Ic					No peak
Weight	g (oz)	165 g (5.8 oz)					
Dimensions	mm (in)	80 x 61 x 24.5 (3.15" x 2.4" x 0.965")					
Digital in/Digital out/ Analog in		6/4/1					
Mounting method		PCB mount					

The following notes apply to all the above Power Rating models up to 100 V and 200 V.

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

4.5. Auxiliary Supply

Feature	Details
Auxiliary power supply	*Isolated DC source only*
Auxiliary supply input voltage	12 VDC up to the specified voltage rate for each servo drive, refer to the 'Maximum auxiliary supply voltage' rate in the 'Power Ratings' table (Section 4.3).
Auxiliary supply input power	7 VA

4.6. Environmental Conditions

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

4.7. Control Specifications

4.7.1. Current Loop

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

4.7.2.   Velocity Loop

Feature	Details
Controller type	PI
Velocity control	• Fully digital • Programmable PI and FFW control filters • "On-the-fly" gain scheduling • Automatic, manual and advanced manual tuning
Velocity and position feedback options	• Incremental Encoder • Digital Halls • Interpolated Analog (Sine/Cosine) Encoder (optional) • Resolver (optional) • Tachometer and Potentiometer (optional) **Note:** With all feedback options, 1/T with automatic mode switching is activated (gap, frequency and derivative).
Velocity loop bandwidth	< 350 Hz
Velocity sampling time	140 to 200 μsec (2x 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.

4.7.3.   Position Loop

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

4.8.   Feedbacks

4.8.1.   Feedback Supply Voltage

The Guitar has two feedback ports (Main and Auxiliary). The Guitar supplies voltage only to the main feedback device and to the auxiliary feedback device if needed.

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

4.8.2.   Main Feedback Options

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

4.8.2.1.   Incremental Encoder Input

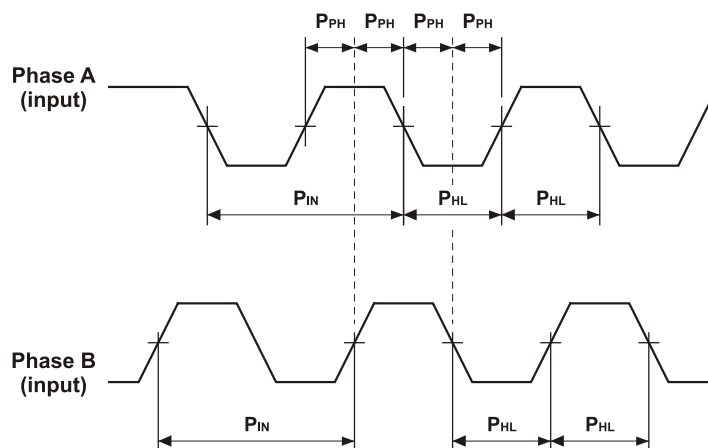| Feature	Details
Encoder format	- A, B and Index - Differential - Quadrature
Interface	RS-422
Input resistance	Differential: 120 Ω
Maximum incremental encoder frequency	Maximum absolute: 5 MHz pulses
Minimum quadrature input period (P_{IN})	112 nsec
Minimum quadrature input high/low period (P_{HL})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

Figure 34: Main Feedback - Encoder Phase Diagram

4.8.2.2.   Digital Halls

Feature	Details
Halls inputs	• H_A, H_B, H_C. • Single ended inputs • Built in hysteresis of 1 V 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): 5 mA
Maximum frequency	f_{MAX} : 2 kHz

4.8.2.3.   Interpolated Analog (Sine/Cosine) Encoder

Feature	Details
Analog encoder format	Sine and Cosine signals
Analog input signal level	• Offset voltage: 2.2 V – 2.8 V • Differential, 1 V peak to peak
Input resistance	Differential 120 Ω
Maximum analog signal frequency	f_{MAX} : 250 kHz
Interpolation multipliers	Programmable: x4 to x4096
Maximum "counts" frequency	80 mega-counts/sec "internally"
Automatic errors correction	Signal amplitudes mismatch Signal phase shift Signal offsets
Encoder outputs	See Auxiliary Encoder Outputs specifications (4.8.3)

4.8.2.4.   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

Feature	Details
Resolver transfer ratio	0.5
Reference frequency	1/Ts (Ts = sample time in seconds)
Reference voltage	Supplied by the Guitar
Reference current	up to ±50 mA
Encoder outputs	See Auxiliary Encoder Output specifications (4.8.3)

4.8.2.5.   Tachometer*

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

* Only one Tachometer port can be used at a time (either TAC1+/TAC1- or TAC2+/TAC2-).

TAC1+/TAC1- is used in applications with having a Tachometer of less than 20 V.

TAC2+/TAC2- is used in applications with having a Tachometer of between 20 V and 50 V.

4.8.2.6.   Potentiometer

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

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

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

Figure 35: Auxiliary Feedback - Encoder Phase Diagram

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

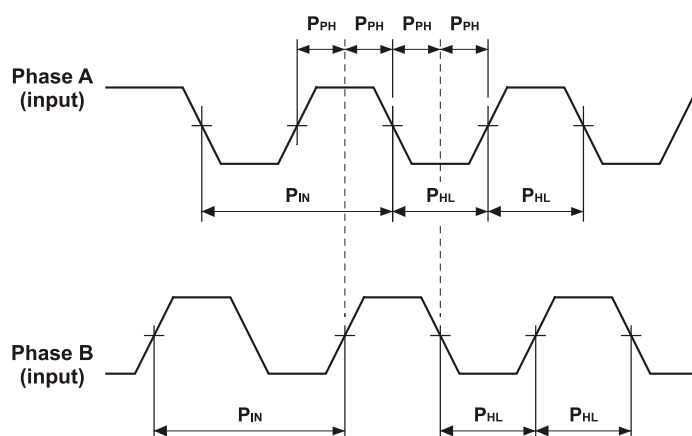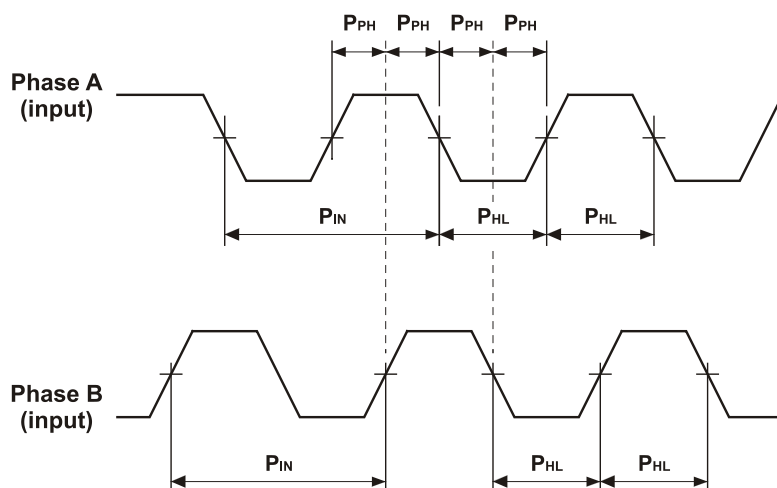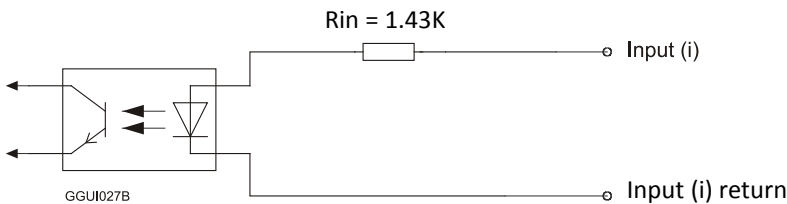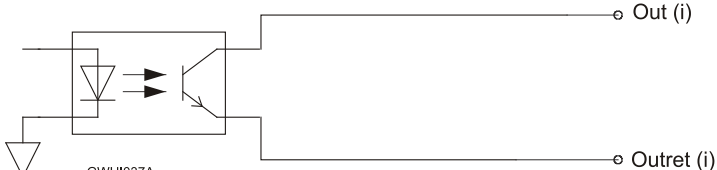| Feature	Details
Encoder input, pulse and direction input	• A, B, Index • Single ended
Input voltage	V_{In} Low: 0 V < V_{IL} < 0.8 V V_{In} High: 2 V < V_{IH} < 5 V Maximum absolute voltage: 0 < V_{In} < 5.5 V Input current: ±1 µA
Available as options	• Single-ended Encoder inputs • Pulse and Direction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

Figure 36: Auxiliary Feedback - Encoder Phase Diagram

4.9. I/Os

The Guitar has:

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

4.9.1. Digital Input Interfaces

Feature	Details
Type of input	- Optically isolated - Each input has its own return
Input current for all inputs	Iin = 2.4 mA @ Vin = 5 V
High-level input voltage	2.5 V < Vin < 10 V, 5 V typical
Low-level input voltage	0 V < Vin < 1 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<4xTS If input is set to General input, execution depends on program. Typical execution time: $\cong$ 0.5 msec.
High-speed inputs – 5 & 6 minimum pulse width, in high-speed mode	T < 5 µsec **Notes:** - Home mode is high-speed mode and can be used for fast capture and precise homing. - High speed input has a digital filter set to same value as digital filter (EF) of main encoder. - Highest speed is achieved when turning on optocouplers.

Rin = 1.43K

Input (i)

Input (i) return

GGUI027B

Figure 37: Digital Input Schematic

4.9.2. 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) (Vout = Low)	I_{out} (max) ≤ 15 mA
VOL at maximum output voltage (low level)	V_{out} (on) ≤ 0.3 V
R_L	The external resistor R_L must be selected to limit the output current to no more than 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.

Out (i)

Outret (i)

GWHI037A

Figure 38: Digital Output Schematic

4.9.3. Analog Input

Feature	Details
Maximum operating differential voltage	± 10 V
Maximum absolute differential input voltage	± 16 V
Differential input resistance	3.74 kΩ
Analog input command resolution	14-bit

4.10. Communications

Specification	Details
RS-232	**Signals:** • RxD , TxD , Gnd • Full duplex, serial communication for setup and control. • Baud Rate of 9,600 to 57,600 bit/sec.
CAN	**CAN bus Signals:** • CAN_H, CAN_L, CAN_GND • Maximum Baud Rate of 1 Mbit/sec. **Version:** • DS 301 V4.01 **Layer Setting Service and Protocol Support:** • DS 305 **Device Profile** (drive and motion control)**:** • DS 402

4.11. Pulse-Width Modulation (PWM)

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

4.12. 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)