



**SERVO  
DYNAMICS**

# D115 – The Fast Optimal Servo Amplifier

For Brush, Brushless, Voice Coil Servo Motors

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This user guide details the servo drives capabilities and physical interfaces. Users will be able to evaluate the applicability to the user requirements and enable the user to hook up and use the servo drive.

#### Revision History

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## Important Notice

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- This document contains proprietary information belonging to Servo Dynamics. This information is provided for the purpose of assisting users of the servo drive in its installation.
- The text and graphics in this document are for the purpose of illustration and reference only.
- The information in this document is subject to change without notice.

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## 1 Introduction

This information manual provides the product specifications, wiring diagram, operational modes (Position, velocity, torque and PWM) and troubleshooting procedures for the D115-Fast Optimal Drive.

### 1.1 Description

The D115 Drive is a Digital Signal Processor (DSP) controlled drive with firmware designed to be very flexible and simple to operate. The controller is easily configured via the Servo Dynamics Host program using a USB connection. The controller has a self-configuration routine which allows the user to put the motor phases lines in any order, Hall signals in any order, and encoder lines in any order. The calibration routine then figures out which one is which. This makes hook up fast and optimal.

From the host the user can configure the controller to operate in the several following options.

- Motor Type
  - Brushless DC
  - Brush motor
  - Voice Coil
- Mode of control
  - Position Control
  - Velocity Control
  - Torque Control (Current Drive)
  - PWM control
- Command Source
  - Analog Voltage Command +/- 10V
  - 4 to 20mA Command
  - RS485 digital Serial command
  - Command Input can be digitally Filtered with settable attack limits
- Feedback Source
  - Hall Signals
  - Incremental Encoder
  - External Analog Source
- Compensation
  - Proportional, Integral, and Derivative (PID) compensation Functions
  - Set, gains, clamps, rate limits, and filters in each PID path
  - PID path can be set for each position, velocity, or torque (current) paths.
  - The PID blocks can be cascaded Position to velocity to current.

If an application requires a unique or specific solution Servo Dynamics Engineering has the capability to customize a solution to your specific needs.

## 1.1 Technical Specifications

**Table 1: Technical Specifications**

Performance Characteristics	
Peak Power	1.1 kW
Peak Output Voltage	± 80 Vdc (shut off @ 95 Vdc) Peak Output Current
	± 15 Amps (30 sec.)
Max. Continuous Current	± 8 Amps (70 °C)
	± 10 Amps (50 °C )
Analog Command and Auxiliary Analog input, Electrical Characteristics	
Signal Voltage range	± 11 VDC (Max.)
Input Impedance (differential)	133.8 k Ohms
Command Input Single Pole Filter	273 Hz
Auxiliary Input Single Pole Filter	217 Hz
Analog command requires a jumper on P4 between pins 1 & 2 and no jumper on P5.	
Input Power Requirements	
Input Voltage	20 - 80 vdc
Over Voltage Shutoff	95V (Internal to the controller)
<p>The Power Supply Bulk Capacitance must have a ripple current rating equal to the continuous motor drive current. This must be physically close to the controller. Insufficient current ripple capability and or significant cable impedance will induce excessive heating at the controller and or erratic behavior.</p> <p>The Power Supply must incorporate a load dump capable of handling the regenerative energy which might flow from the motor/load system. Failure to design for this will result in a failed controller and or power supply.</p>	
4 to 20 mA command	
<p>This command uses the same circuitry as the Analog command and requires a jumper on P4 pins 2 &amp; 3 and a jumper on P5 pins 1 &amp; 2.</p>	
Input impedance	249 ohms
RS485 Interface	
<p>Input A has a 750 ohm pull up to +5V            Input B has a 750 ohm pull down to ground.            Common Mode Voltage range -7V to +12V and differential threshold of +/- 0.2V.            For complete specification consult SP485E data sheet.            To implement end of line 150 ohm termination, connect A-term to B at P2 pins 30 to 31.</p>	

#### Digital Inputs

- Hall inputs, Quadrature Encoder Inputs, have 1K pull up resistors to 5V.
- Hall and Encoder inputs maximum pulse frequency is 1MHz.
- Digital Inputs have an internal 4.7K resistor pull up to +5V. Din 1 thru 4 are on P2-15, 33, 14, and 32 respectively.
- Enable function is dedicated to Din 4. The controller only enables on a transition from off to on to prevent unexpected motion on power up. Controller enables from open (High) to closed (low).
- Sync In and Home Find have a 4.7K resistor pull up to 3.3V.
- Sync in function will hold off mode changes when held low. This allows configuration changes to be synchronized between multiple controllers.
- Home Find - When controller is placed in home find mode and external switch is selected to determine home position the controller will look for this input to be pulled low. When this occurs the controller sets the position count to zero and stops the home find movement.

#### Digital and Discrete Outputs

- Digital out 1 and 2 are 5V logic levels with a 100 ohm source impedance.
- Low Drive 1 and 2 are open collector 60V MOSFETS for use in driving external loads.
- Low Drive 1 and 2 are rated for 1.4A each over the entire temperature range.

#### Motor Thermistor Sense

The motor thermistor interface is designed to interface to Vishay BC Components part number NTCLE203E3104GBO. This will provide 5% accurate temperature monitoring. If the motor has a normally open thermo switch the terminals can be connected between the sense input and ground. The closing of the thermo switch would trip a temperature threshold set via the host software and parameter file.

#### 5V power for Hall and Encoder

5V (4.7V to 5.1V) at 125mA nominal.  
Short Circuit Protection – indefinite.

#### Physical Characteristics

Module Dimensions (L x W x H)	5.4 in. x 1.0 in. x 3.2 in.
Weight	0.70 lb.
Ambient Temperature – Operating	0 °C to 50 °C
Shutdown Temperature	80 °C at heat sink
Relative Humidity	5 - 95% non-condensing

## 2 Safety Information

### 2.1 Electrical Cautions

- Ensure that the negative terminal of the bus capacitor is grounded to the earth ground.

Improper grounding may cause erratic operation or a safety hazard due to common mode voltages.

- An isolation step-down transformer or isolated regulated supply must be used for the power supply of this unit.
- Make sure that all voltages and tests are made with battery powered or electrically isolated instruments.

## 3 Connector Information

### 3.1 P1 Terminal Block / Power Connector

**Table 2: Power Connector**

Pin Number	Signal Name
1	V+ Power Source (20 to 80V DC)
2	V Return Power Source
3	Phase A Motor Connection
4	Phase B Motor Connection
5	Phase C Motor Connection

### 3.2 P2 Connector 37 pin

Table 3: P2 Connections

Pin No	Signal Name	Description
1	+5V external	Hall Device and Encoder Power
2	Hall 1	Hall Device Input. Phase A, B, or C. See Note 1.
3	Hall 2	Hall Device Input. Phase A, B, or C. See Note 1.
4	Hall 3	Hall Device Input. Phase A, B, or C. See Note 1.
5	Gnd	
6	Gnd	
7	Sync In	A pull down to ground inhibits mode changes.
8	4 to 20mA +	4 to 20mA command input. 249 ohm load. P5 must have jumper and P4 jumped between pins 2 & 3.
9	4 to 20mA return	
10	Auxiliary Analog In +	Auxiliary Analog In for feedback. Pin 29 is return
11	Gnd	
12	A input	RS485 input for digital serial communication
13	B input	RS485 input for digital serial communication
14	Din 3	Digital Input used for mode selection and logic pass through.
15	Din 1	Digital Input used for mode selection and logic pass through.
16	Dout1	5V logic output with 100 ohm source impedance.
17	Home Find In	Home Find Switch Input.
18	Gnd	
19	Chassis Gnd	For use in cable shielding requiring chassis connection.
20	+5V external	Controller supplied power for Hall Device and Encoder.
21	QE -1	Quadrature Encoder Input A or B. See Note 1.
22	QE -1	Quadrature Encoder Input A or B. See Note 1.
23	QE -I	Index line of quadrature encoder.
24	Gnd	
25	Gnd	
26	Motor Thermistor	Motor Thermistor Connection. Other Connection is to Gnd.
27	Analog Command +	Positive Analog Command
28	Analog Command -	Negative Analog Command
29	Auxiliary Analog In -	Auxiliary Analog In for feedback. Pin 10 is positive input.
30	A -Termination	Connecting A – Termination to B input places a 120 ohm end of line termination for the RS485 bus.
31	B input	
32	Enable	Enables controller on <i>transition</i> from off to on.
33	Din 2	Digital Input used for mode selection and logic pass through.
34	Gnd	
35	Dout2	5V logic output with 100 ohm source impedance.
36	Low Drive 1	Open Collect 60V MOSFET Output. 1.4A capable.
37	Low Drive 2	Open Collect 60V MOSFET Output. 1.4A capable.

Note 1 – Placement order is irrelevant as the calibration routine figures out and memorizes what the order is.



### 3.3 Mounting Dimensions

Note: Units in inches

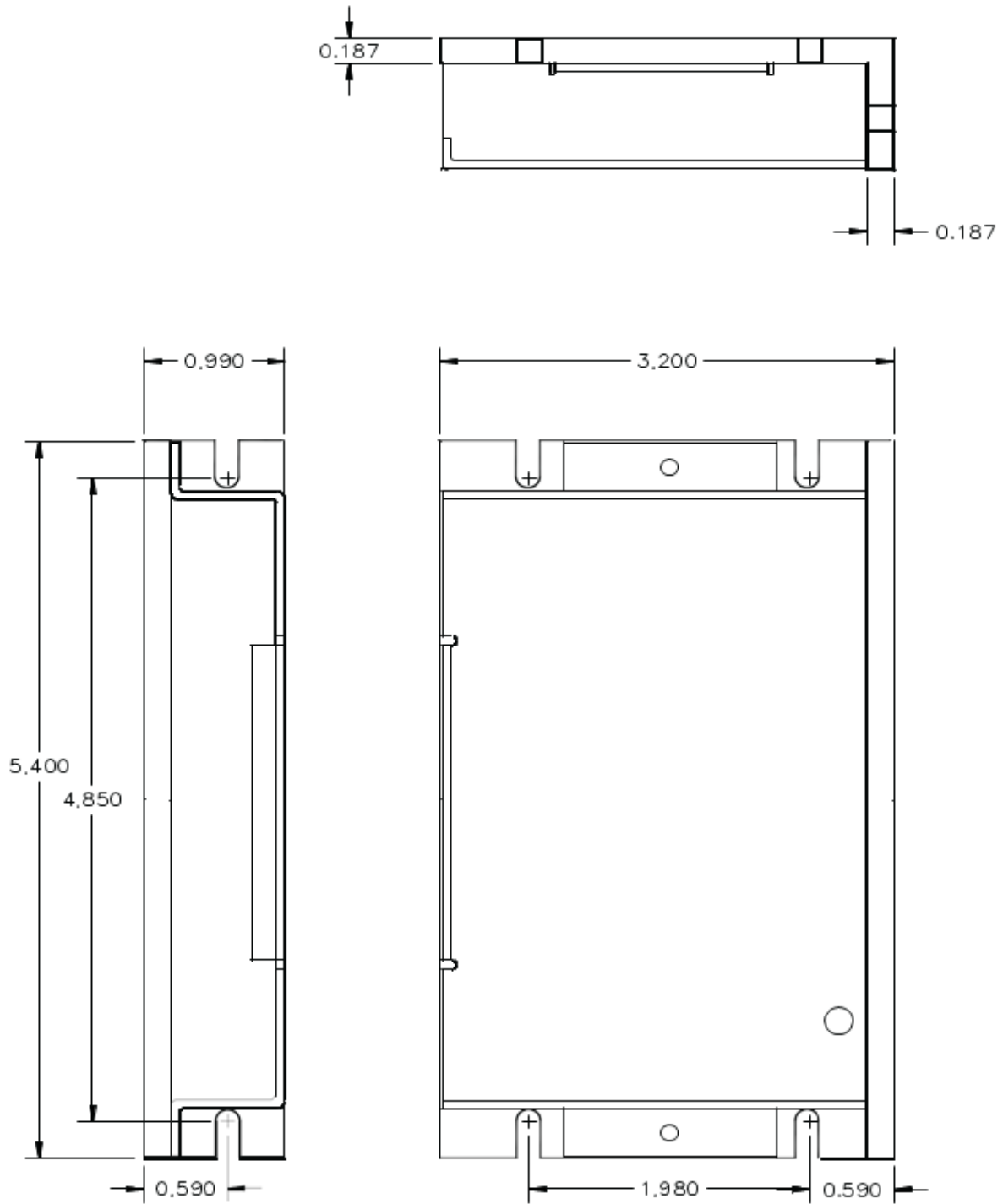


Figure 1 Mounting Dimensions

## 4 Application Guide

### 4.1 Input Power

The input power for any servo motor drive system must take into account the current surges both positive and negative along with continuous ripple current.

If the supply cannot supply the surge which occurs during acceleration the supply voltage will drop below the minimum and the controller may reset. In the condition of the servo drive slows or reverses a motor with an aiding load the motor will generate power back through the controller to the input power. If the voltage pumps beyond 100V, components internal to the drive will catastrophically fail. Therefore an adequately sized load dump circuit with appropriately selected trip level must be included in the system power source.

Ripple current occurs at 20KHz which is the power stage switching frequency. The internal capacitance is rated for 1Arms continuous. The power supply should have adequate capacitance and ripple current rating to the system continuous operation. The power supply should be placed as close as possible to the controller to ensure the parasitic cable impedance does not limit the continuous ripple current.

### 4.2 Analog Command and 4 to 20mA Command Input

The schematic below is of the versatile Analog Differential amplifier. If 4 to 20mA command is desired P5 connects the 249 ohm resistor in as a termination load and P4 connect pin 2 to 3. If a +/- 10V command is desired P5 connection is removed and P4 connects pin 1 to 2. The drive is shipped in the +/- 10V command configuration.

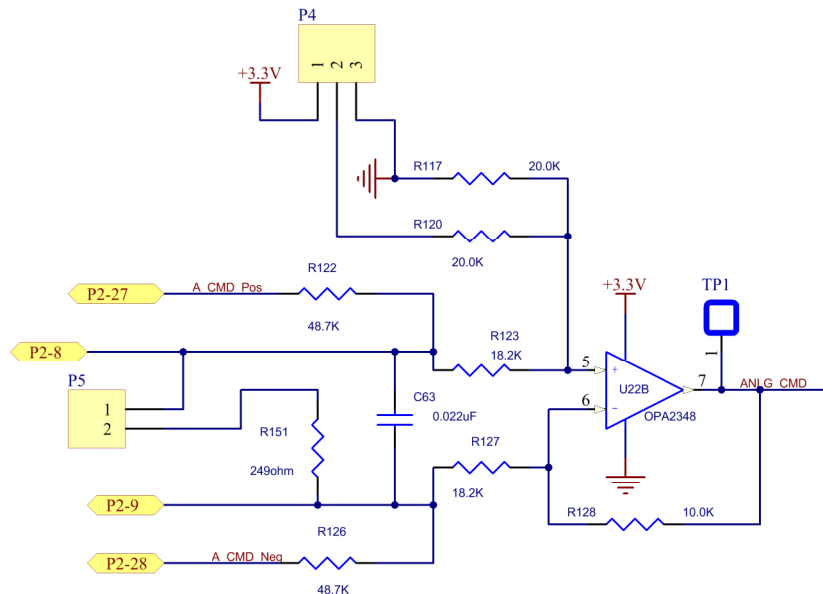


Figure 2: Analog Differential Command Amplifier

### 4.3 Auxiliary Analog Input (Feedback)

The Auxiliary A to D input has a differential amplifier circuit. The input range is +/- 10V. The input range can be extended by adding external resistors.

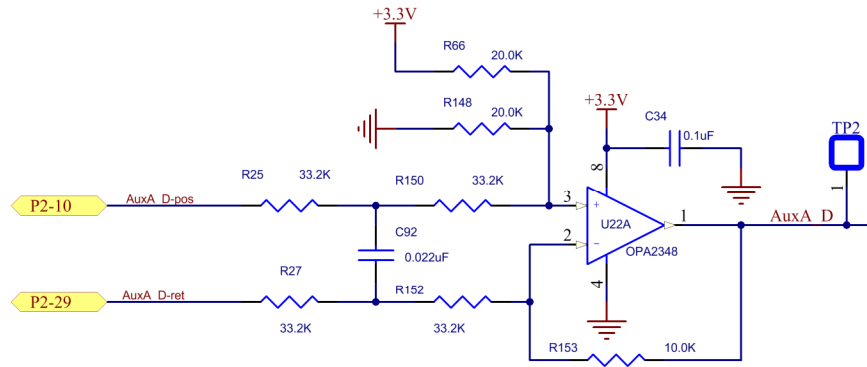


Figure 2: Auxiliary Analog Input Differential Amplifier

### 4.4 Digital Inputs

#### 4.4.1 Enable Input and Mode Select Inputs

The following schematic is of the 4 digital inputs to the controller. The user connects to Din1 through 4. Din1 thru 3 select the operating mode (0 – 7). The enable input is dedicated to Din4.

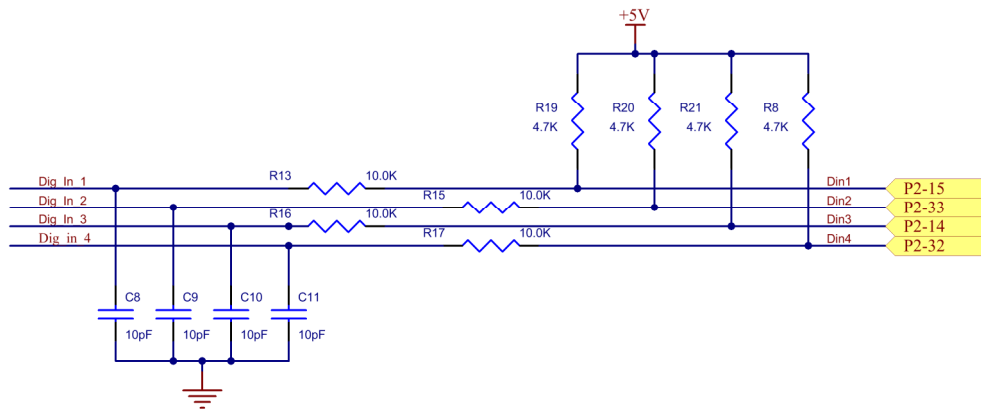


Figure 3: Mode Control Digital Inputs

#### 4.4.2 Hall Input and Encoder Inputs

The following schematic is of the three Hall inputs. An identical circuit is used to interface to the encoder signals.

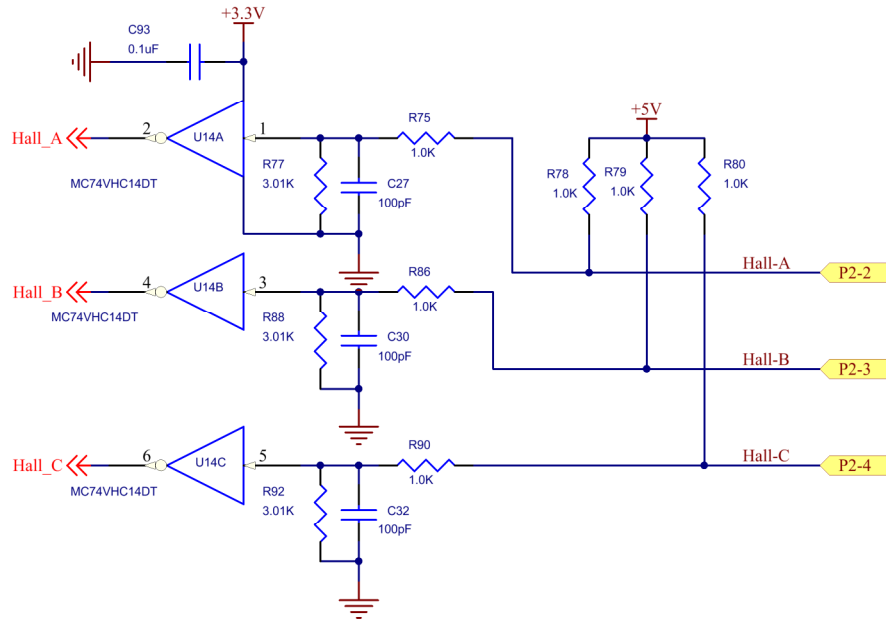


Figure 4: Hall and Encoder Signal Input Circuits

#### 4.4.3 Home Find and Sync In

The Home Find and Sync input circuits are as shown. The “Sync In” line will prevent mode changes via Din 1 thru 3 from occurring when Sync is low. This enables synchronizing multiple drives. The Home find input is used if the drive is configured to use an external switch. The external switch should connect to ground to indicate the home location was reached.

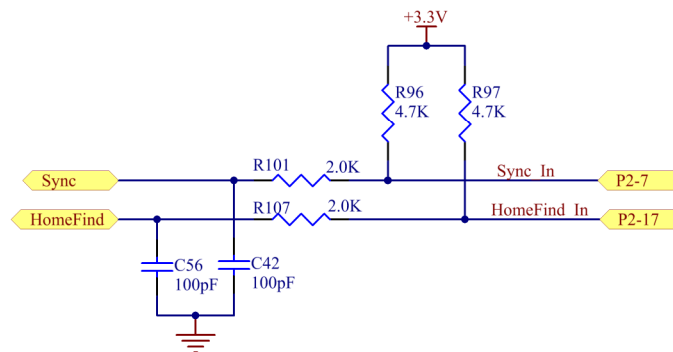


Figure 5: Home Find and Sync Input

## 4.5 Digital Outputs

The two digital outputs are available to external high impedance circuits. There are clamping diodes in U6 to enhance protection against ESD or electromagnetic coupled transients on the digital output lines.

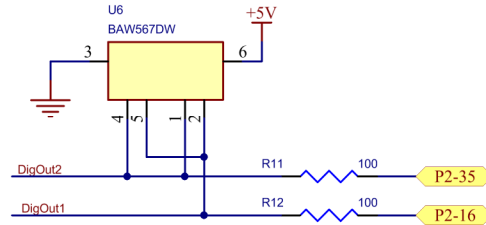


Figure 6: Digital outputs

## 4.6 Low Side High Current Drive

There are two Low Side transistors that are driven from the digital outputs. This circuit is shown in figure 7. These are not current limited and therefore the user should be careful to not create a situation where the current can get beyond 1.4 A. In addition, if this is used to drive a relay or a reactive coil of any kind, the user is responsible to ensure that the deactivation flyback voltage does not exceed the rating of the MOSFET.

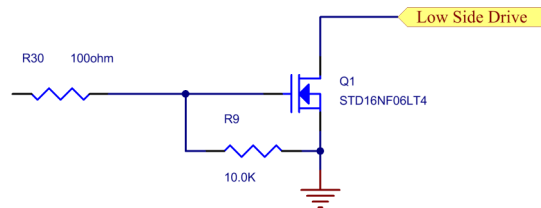


Figure 7: Low Side Drive Circuit

## 4.7 Motor Thermistor Interface

The motor thermistor circuit is a simple bias resistor to 3.3V. The external thermistor connects to the bias resistor and ground. The voltage sense point is read by the processor A to D. The processor compares the reading to the set point set in the drive fault parameters. The set point is adjustable via the host program. This design assumes decreasing resistance with temperature.

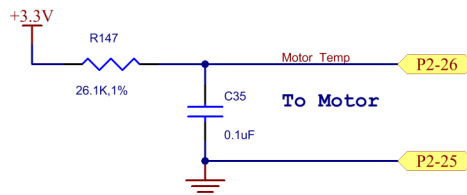
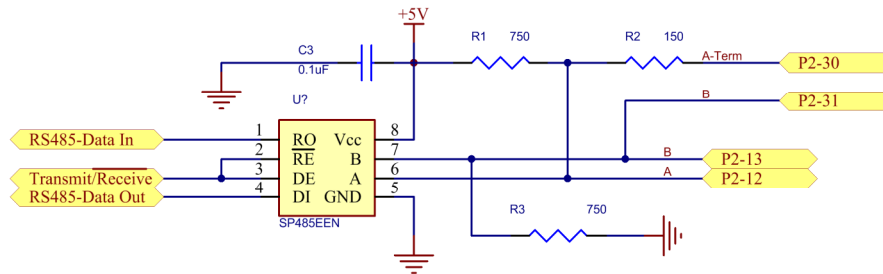


Figure 8: Motor Thermistor bias

## 4.8 RS485 Interface

The RS485 interface can be configured to be the end termination. This is done by connecting the P2-30 to P2-31. The controller can be given address via the host software.



## 4.9 USB Interface

The USB interface has two LED's associated with it, Red and Blue. The Red LED will be steady on if no USB connection is present. It will flash RED when a USB connection is sensed but not connected. The blue will be steady on when the drive is connected.

## 4.10 LED Status Signals

There are two controller status LED's, one Green and one Red. The Green LED will light steady on when the controller is enabled and off when not. The Red LED will flash fault code numbers. The coding is very straight forward. It will flash once, pause, and repeat for fault 1. For Fault 2 it will flash twice, pause and repeat. The sequence is per the faults tab sequence in the Host program. If multiple faults occur it will go through them sequentially and repeat.

## 5 Contact Information

If you are unable to resolve any problem, consult our web page located at:

<http://www.servodynamics.com/>

Contact the service department at Servo Dynamics:

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