

Dynamo Brushless DC Motor and GreenDrive™ Manual



This manual was developed as a guide for use by FIRST Robotics Teams using Controller Part Number 840205-000 in conjunction with the Nidec Dynamo BLDC Motor.

Nidec Motor Company, 2009
Printed in United States of America

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Part Number: TDE840205-000

Revision: 1

Date: November 13, 2017

Nidec Motor Company, 2017



▲ WARNING

Read this Operator's Manual carefully before using this device. Failure to understand and follow the contents of this manual may result in electrical shock, fire and/or serious personal injury.

Nidec
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This document has been prepared to conform to the current released version of the product. Because of our extensive development efforts and our desire to further improve and enhance the product, inconsistencies may exist between the product and documentation in some instances. Call your customer support representative if you encounter an inconsistency.

CUSTOMER SUPPORT

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It is Nidec Motor Company's goal to ensure your greatest possible satisfaction with the operation of our products. We are dedicated to providing fast, friendly, and accurate assistance. We offer you many ways to get the support you need. Our wide range of services include:

FAX	(812) 386-7504
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You can FAX questions and comments to Nidec Motor Company. Just send a FAX to the number listed above.

Website	www.hurst-motors.com
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If you have Internet capabilities, you also have access to technical support using our website. The website includes technical notes, frequently asked questions, release notes, and other technical documentation.

Customer Service (Sales)	(812) 385-2564
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Nidec Motor Company

Brushless DC Motor and GreenDrive™ Manual

TABLE OF CONTENTS

<i>Customer Support</i>	3
<i>Table of Contents</i>	4
<i>List of Figures</i>	6
<i>List of Tables</i>	6
<i>Safety Symbols</i>	7
<i>General Safety Rules</i>	8
Safety Precautions	8
Qualified Person	8
Setup, Commissioning and Maintenance	8
Safety of Machinery	9
<i>Specific Safety Information</i>	9
<i>Introduction</i>	10
<i>Features</i>	10
<i>Product Description</i>	10
<i>Getting Started</i>	11
<i>Mounting Recommendations</i>	12
<i>Dynamo Motor Size 17</i>	12
Axial & Radial Loading Recommendations	12
<i>Axial & Radial Loading Recommendations</i>	<i>Error! Bookmark not defined.</i>
<i>Choosing a Power Supply</i>	13
Motor Power Supply	13
<i>Connecting inputs and outputs</i>	14
Motor Power Supply Connections	14
<i>Control Connections</i>	15
<i>Inputs/Outputs</i>	17
Tachometer (Pin 1)	17

Externally Supplied Voltage Command Input	17
PWM (Pin 3).....	17
Direction (Pin 6).....	18
PWM & Direction (Pin 7).....	18
Enable (Pin 8).....	18
GND (Pin 9).....	19
+5 Vdc (Pin 10) (Input).....	19
<i>PWM & Direction</i>	20
Mechanical Specifications	21
<i>Dimensional Outline Drawings</i>	21
Dynamo Size 17 Motor	21
<i>Cables & Mating Connectors</i>	21

LIST OF FIGURES

FIGURE 1 - DYNAMO SIZE 17 MOTOR	12
FIGURE 2 - POWER SUPPLY CONNECTIONS (C1)	14
FIGURE 3 - CONTROL CONNECTIONS (C2)	15
FIGURE 4 - TACHOMETER AND DIRECTION INDICATION OUTPUTS	18
FIGURE 5 - PWM & DIRECTION CONTROL METHOD W/O INTERNAL 5 VDC SUPPLY (TYPICAL CONNECTIONS)	20
FIGURE 6 - DYNAMO SIZE 17 MOTOR	21
FIGURE 7 - MOTOR POWER SUPPLY CABLE (HURST PART NUMBER: 120016)	21
FIGURE 8 - MOTOR POWER SUPPLY MATING CONNECTOR (C1)	22
FIGURE 9 - CONTROL CABLE (HURST PART NUMBER: 120106)	23
FIGURE 10 - CONTROL MATING CONNECTOR (C2)	23

LIST OF TABLES

TABLE 1 - MOTOR POWER SUPPLY CONNECTOR PIN FUNCTIONS (C1)	15
TABLE 2 - CONTROL CONNECTOR PIN FUNCTIONS (C2)	16
TABLE 3 - MOTOR POWER SUPPLY CABLE REFERENCE	22
TABLE 4 - CONTROL CABLE REFERENCE	24

SAFETY INFORMATION

Safety Symbols

In this operator's manual and on the product, safety symbols and signal words are used to communicate important safety information. This section is provided to improve understanding of these signal words and symbols.



This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.



DANGER indicates a hazardous situation which, if not avoided, will result in death or serious injury.



WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury.



CAUTION indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.



NOTICE indicates information that relates to the protection of property.



This symbol means read the operator's manual carefully before using the equipment. The operator's manual contains important information on the safe and proper operation of the equipment.



This is the electrical shock symbol.

General Safety Rules

⚠ WARNING

Failure to follow safe installation guidelines can cause death or serious injury. The voltages used in motion control systems can cause severe electric shock and/or burns, and could be lethal. Extreme care is necessary at all times when working with or adjacent to this equipment. The installation must comply with all relevant safety regulations and standards in the country of use.

Safety Precautions

This product is intended for professional incorporation into a complete system by qualified persons. If you install the product incorrectly, it may present a safety hazard. The product and system may use high voltages and currents, carry a high level of stored electrical energy, or are used to control mechanical equipment that can cause injury. You must give close attention to the electrical installation and system design to avoid hazards either in normal operation or in the event of equipment malfunction. System design, installation, commissioning, and maintenance must be carried out by personnel who have the necessary training and experience. Read and follow this safety information and this instruction manual carefully.

Qualified Person

For the purpose of this manual and product, a “qualified person” is one who is familiar with the installation, construction, operation, and potential hazards associated with the equipment into which this motor and drive will be installed. In addition, this individual has the following qualifications:

- Is trained and authorized to energize, de-energize, clear and ground and tag circuits and equipment in accordance with established safety practices.
- Is trained in the proper care and use of protective equipment in accordance with established safety practices.
- Is trained in rendering first aid.

Setup, Commissioning and Maintenance

It is essential that you give careful consideration to changes to control settings. Depending on the application, a change could have an impact on safety. You must take appropriate precautions against inadvertent changes or tampering. Restoring default parameters in certain applications may cause unpredictable or hazardous operation.

Safety of Machinery

All machinery in which this product is used must comply with all federal, state, and local safety standards. The level of integrity offered by the product's control function - for example stop/start, forward/reverse and maximum speed is not sufficient for use in safety-critical applications without additional independent channels of protection. All applications where malfunction could cause injury or loss of life must be subject to a risk assessment, and further protection provided where needed.

NOTICE

Fuses

Fuses or over-current protection must be provided in accordance with the National Electrical Code and any additional local codes.

Specific Safety Information

Users must determine the suitability of the control for their application, including the level of reliability required, and are solely responsible for the function of the end-use product. These controls contain exposed electrical components and are not intended to withstand exposure to water or other environmental contaminants which can compromise insulating components. Such exposure may result in insulation breakdown and accompanying localized electrical heating.

⚠ WARNING

A control may remain permanently closed or open as a result of exposure to excessive mechanical, electrical, thermal or environmental conditions or at normal end-of-life. If failure of the control to operate could result in personal injury or property damage, the user should incorporate supplemental system control features to achieve the desired level of reliability and safety. For example, backup controls have been incorporated in a number of applications for this reason.

INTRODUCTION

Thank you for selecting the Dynamo Motor powered by the integrated GreenDrive™ control. This manual contains all basic and necessary information concerning the brushless DC motor and GreenDrive™ control.

If you require any additional information, please contact Nidec Motor Company/Hurst Division at 812-385-2564 or hurst@nidec-motor.com.

Features

- NEMA 17 Motor
- Ball Bearing System
- Stainless Steel Shaft
- 12 to 36 Vdc Input Voltage
- Closed Loop Speed Operating Mode
- Pulse Width Modulated (PWM) Control Method
- Enable and Direction Inputs
- Efficiency up to 85%
- Tachometer Output
- 4-Quadrant Operation
- Current Limit Protection
- Under Voltage Protection
- Industry Standard Connectors

Product Description

The Nidec brushless DC motion control system is an integrated, variable-speed brushless DC motor and control package. This system includes a low voltage customer interface that can be connected to a system controller or connected to an external potentiometer, forward/reverse switch, run/stop switch, or other user I/O. The motor is equipped with a triple-fixed preloaded ball bearing system and multiple mounting arrangements. The system also includes internal current limiting, and under voltage protection for system safeguarding.

Two channel encoder signals are available to close system loop internally or externally. The encoder also permits the user to determine speed and direction of the motor. A Tachometer signal is also accessible for a low cost alternative to the encoder.

The integrated motor control includes a power amplifier designed to operate directly from a DC voltage input of 12 to 36 volts. The power amplifier contains an inverter and an optional low

voltage power supply. The inverter converts input DC power into three phase voltages. The optional low voltage power supply can be used to supply an auxiliary 5 Vdc to power additional customer circuitry.

The GreenDrive™ also includes a variety of control methods and operating modes. The integrated motor operating modes are:

- Closed loop speed - Together with the internal two-channel quadrature encoder or tachometer signal, allows the user to close a speed loop internally to the control for applications requiring minimum speed variation with varying loading.

The system control methods are:

- PWM & Direction - Varies speed and direction based on PWM duty cycle.

GETTING STARTED

Minimum Requirements:

Hurst BLDC Motor

Power Supplies

- Motor Power Supply 12 to 36 Vdc (dependent on motor rating)
- Control Power Supply 0 to 5 Vdc optional internal power supply available

Customer Data Sheet

Cables available upon request



Refer to the label on the motor to retrieve information about rated speed, torque, voltage, and current.

MOUNTING RECOMMENDATIONS

Dynamo Motor Size 17

Axial & Radial Loading Recommendations

- Radial - 10lbs max [45N max]
- Axial - 2lbs max [9N max]

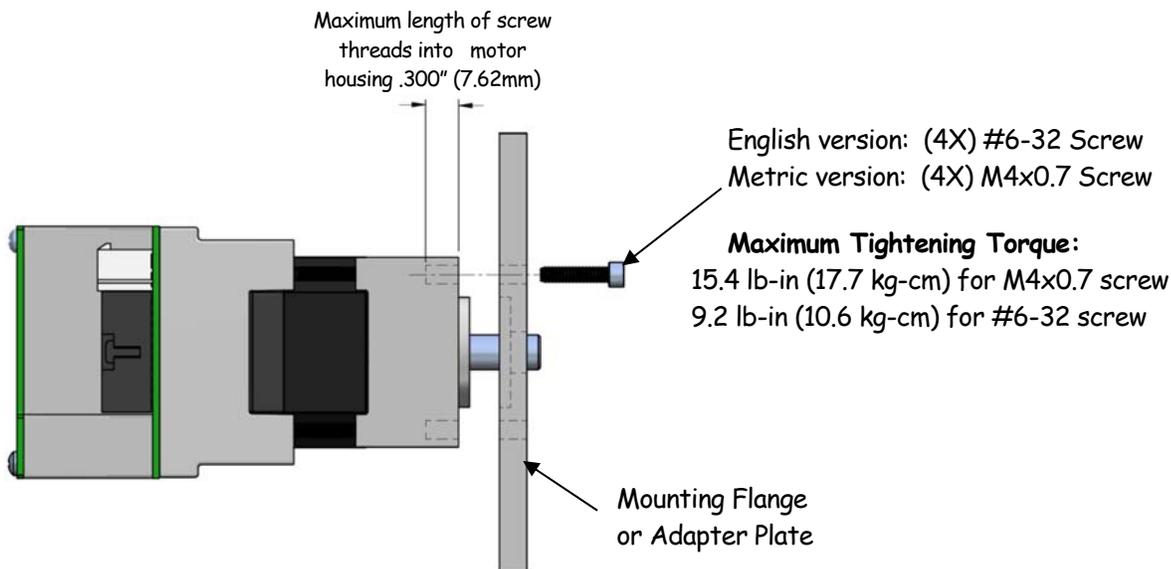
The threaded mounting holes on the motor housing have a depth as shown in the figure below.

NOTICE

Using screws longer than specified will result in the screw bottoming-out in the motor housing and not securing the motor properly.

The figure below illustrates the screw thread sizes, thread engagement length and torque requirements for mounting the Dynamo Size 17 motor.

FIGURE 1 - DYNAMO SIZE 17 MOTOR



At 25°C ambient the max motor winding operating temperature rise is 65°C with motor mounted to a 4" x 4" x 0.25" aluminum plate. See Technical Specifications, Mechanical Outline, Dynamo Size 17 Motor for additional information.

CHOOSING A POWER SUPPLY

There are two important parameters to consider when choosing a power supply in your application, voltage and current.

Motor Power Supply

- **Voltage Input Range: 12 to 36 Vdc**

Refer to your motor label for rated voltage. The integrated motor control is intended to be operated from a low voltage DC power supply rated between **12 to 36 Vdc**. The maximum voltage of the GreenDrive™ is 42 Vdc, therefore do not exceed this voltage. The maximum continuous operating current handled by the GreenDrive™ is 10 amps. Where the maximum motor current is less than 10A, the power supply rating should be based on the rated motor current as shown on the nameplate. Filter capacitors are supplied internal to the GreenDrive™ control for increased reliability under typical power conditions. It is recommended that the power supply meet the latest editions of UL60950 and CSA 60950 specifications.

- **Current Input Range: 3x Rated Motor Current (Typical)**

The maximum or rated power supply current needed should typically be at least three times the rated motor current to ensure adequate current headroom for intermittent motor overloading.

Connecting inputs and outputs

Motor Power Supply Connections

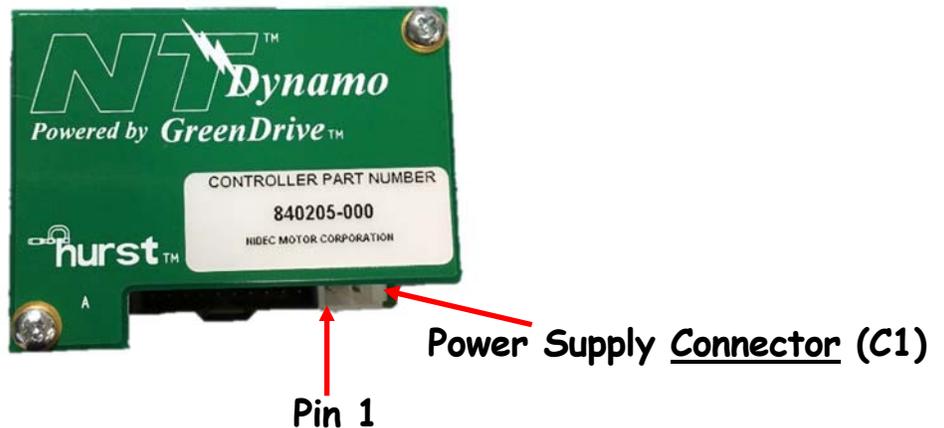
CAUTION

Never connect or disconnect the power supply to a motor or control while the power is turned on. Minor or moderate injury could result if not avoided.



All wire gauge sizes must be in accordance with all federal, state, and local codes.

FIGURE 2 - POWER SUPPLY CONNECTIONS (C1)



Connect the power supply to the GreenDrive™ using a 2-pin connector (Molex P/N 39-01-2020 or equivalent) and terminals (Molex P/N 39-00-0039 or equivalent).

1. Connect the positive lead from the external power supply to pin 1 on the motor's power supply connector labeled as C1 .
2. Connect the negative lead from the external power supply to pin 2 on the motor's power supply connector labeled as C1 .

TABLE 1 - MOTOR POWER SUPPLY CONNECTOR PIN FUNCTIONS (C1)

Pin No.	Description	Input/ Output	Notes
1	+DC	Input	12-36 Vdc, Maximum continuous current is 10A
2	GND	Input	

Control Connections

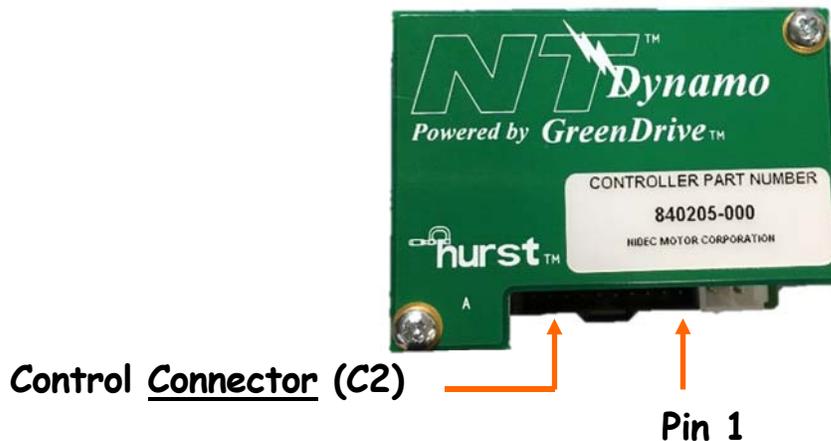
CAUTION

Never connect or disconnect the power supply to a motor or control while the power is turned on. Minor or moderate injury could result if not avoided.



All wire gauge sizes must be in accordance with all federal, state, and local codes.

FIGURE 3 - CONTROL CONNECTIONS (C2)



Connect the control inputs and outputs to the GreenDrive™ using a 10-pin connector (Molex P/N 50-57-9410 or equivalent) and terminals (Molex P/N 16-02-0103 or equivalent).

TABLE 2 - CONTROL CONNECTOR PIN FUNCTIONS (C2)

Pin No.	Description	Input/Output	Notes
1	Tachometer	Output	Speed Output - 15 Pulses/Revolution (PPR) for Dynamo at TTL Level (0 to 5 Vdc) and 50% Duty Cycle
2	NA	--	--
3	PWM	Input	Input - PWM Control Method <ul style="list-style-type: none"> • 0% duty cycle minimum command • 100% duty cycle maximum command • Used with Direction Input pin (Pin 7)
4	NA	--	--
5	NA	--	--
6	Direction	Output	Direction Output - 0 Vdc output = clockwise lead end 5 Vdc output = counter-clockwise lead end Can be used in conjunction with Tachometer output (Pin 1) to determine speed and direction
7	PWM & Direction	Input	PWM & Direction - <ul style="list-style-type: none"> • 0% duty cycle maximum command in the counterclockwise direction lead end • 50% duty cycle minimum command • 100% duty cycle maximum command in the clockwise direction lead end
8	Enable	Input	Low level signal (0 Vdc) enables drive
9	GND	--	Return path for + 5 Vdc (Pin 10)
10	+5 Vdc	Input	Input - User supplied 5 Vdc

Inputs/Outputs

Tachometer (Pin 1)

Tachometer outputs are generated from an internal controller by the three hall effect sensors. On the standard Dynamo motor, the output is 15 pulses per revolution. The tachometer output provides speed information. At each commutation point, the tachometer output changes state independent of motor direction. The GreenDrive™ can be used in conjunction with the Direction output (Pin 6). See Table 2 for additional information.

Externally Supplied Voltage Command Input

The user must supply a 0-4 Vdc input into Pin 2 on the control connector. If a 5 Vdc supply is to be used, a 22 K Ω resistor must be placed in series with a 100 K Ω potentiometer. If a 4 Vdc supply is used, a resistor is not needed. The potentiometer consists of three pins, a supply voltage input, a GND input and a variable command output. The user can adjust the command output by adjusting the potentiometer with the wiper connected to the command input and the other two potentiometer connections attached to the control connector Pin 10 and control connector Pin 9 pins.

NOTICE

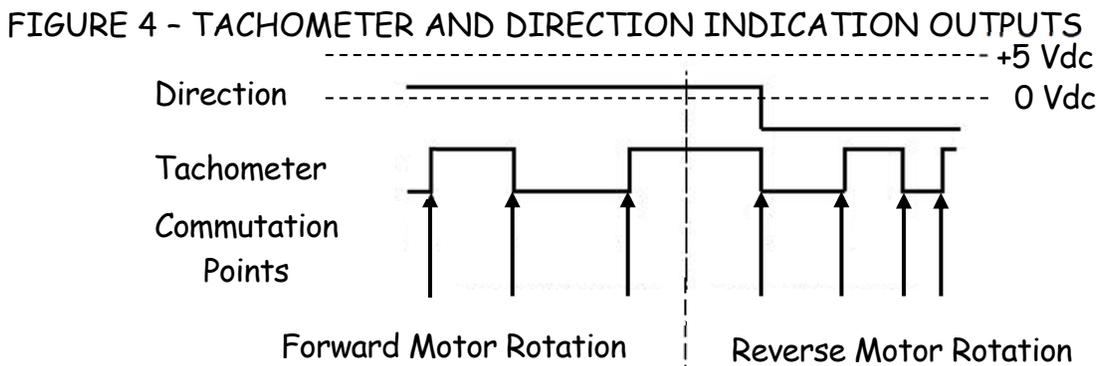
In torque mode, care must be taken by the user not to exceed the 0-4 volt range of the variable command input (Pin 2). Voltages outside this range could cause permanent damage to the control.

PWM (Pin 3)

The PWM input can be used in Open Loop Speed and Closed Loop Speed Operating Modes. The PWM input operates in PWM Control method, where the PWM command is from 0 to 100%; 0% being no current applied to the windings and 100% full current applied to the windings. The frequency of the PWM signal in the PWM control method operates between 15 kHz and 25 kHz.

Direction (Pin 6)

Direction outputs are generated from an internal controller by the three hall effect sensors. When the motor is rotating clockwise from the lead end, the direction output will be considered a low level (GND). When rotation is counter-clockwise from the lead end, the direction output will give a high level (5 Vdc). The GreenDrive™ can be used in conjunction with the Tachometer output (Pin 1). The figure below displays additional information about the direction and tachometer output.



PWM & Direction (Pin 7)

The PWM & Direction input can be used in Open Loop Speed and Closed Loop Speed Operating Modes. The PWM & Direction input operates in PWM & Direction Control Method where 0% duty cycle maximum command in the counterclockwise direction (viewed from the lead end), 50% duty cycle minimum command (0 input), 100% duty cycle maximum command in the clockwise direction (viewed from the lead end). The frequency of the PWM signal in the PWM & Direction control method operates at 2.5kHz.

Enable (Pin 8)

The Enable input is used in all control methods and operating modes. A low level (0 Vdc) on the Enable pin enables the control to start the selected Control Type. A high level (+5 Vdc) on the Enable input causes the GreenDrive™ to stop controlling the motor, thus allowing the motor to coast. This line has an internal 2.15kΩ pull up resistor. The 2.15kΩ pull up resistor requires the pin to be driven by a circuit capable of sourcing at least 2.33 mA.

GND (Pin 9)

The GND pin (Pin 9) is the return path for + 5 Vdc (Pin 10) input/output pin. It is also common connection for External, Analog or PWM Control Methods. Pin 9 (Gnd), is common to the (Gnd) terminal of the power supply connector. Use isolated input signals as required to avoid ground loop issues.

+5 Vdc (Pin 10) (Input)



In this section, pin 10 is described as an externally supplied input. If you selected the internally generated output, see the section below.

- **Voltage Input Range: 4.75 to 5.25 Vdc**
- **Current Input: power supply must provide a minimum of 56 mA**

The +5 Vdc input is externally supplied by the end user depending on the GreenDrive™ option selected.

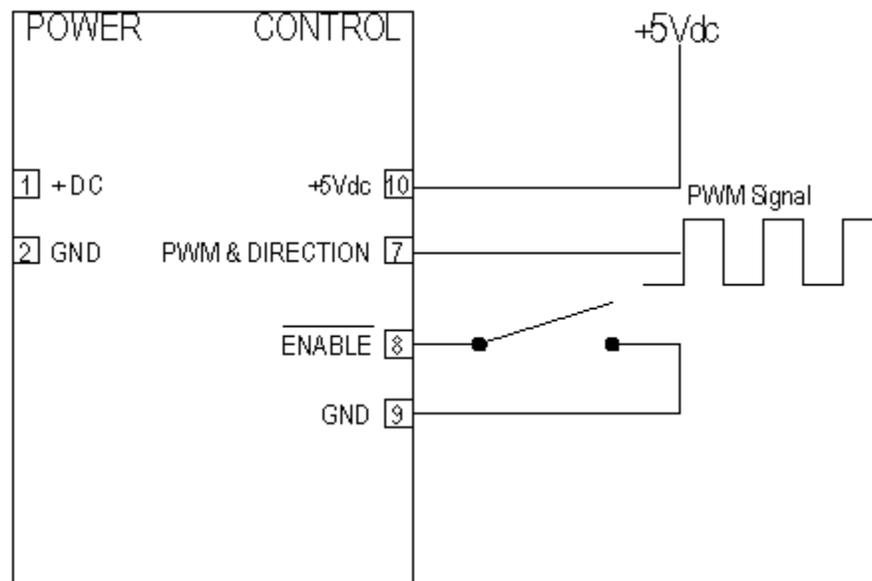
The +5 Vdc input provides power for internal electronics. The user supplied +5 Vdc input is critical to the performance of the motor control. Care and attention must be taken not to deviate away from voltage specifications to prevent potential harm to the motor control system.

PWM & DIRECTION

- PWM & Direction - Pin 7
- Enable - Pin 8

The PWM & Direction mode accepts a PWM signal on the Direction input pin (Pin 7) on the control connector to control speed and direction. PWM & Direction permits the user to vary input command and direction with change in duty cycle input. The PWM signal should be an active high PWM signal at 25 kHz to the PWM input pin. A 0% duty cycle input indicates maximum command in the counterclockwise direction when viewing the motor from the lead end. A 50% duty cycle input indicates minimum command. A 100% duty cycle input indicates maximum command in the clockwise direction when viewing the motor from the lead end. A high level on the Enable pin enables the drive.

FIGURE 5 - PWM & DIRECTION CONTROL METHOD W/O INTERNAL 5 VDC SUPPLY (TYPICAL CONNECTIONS)

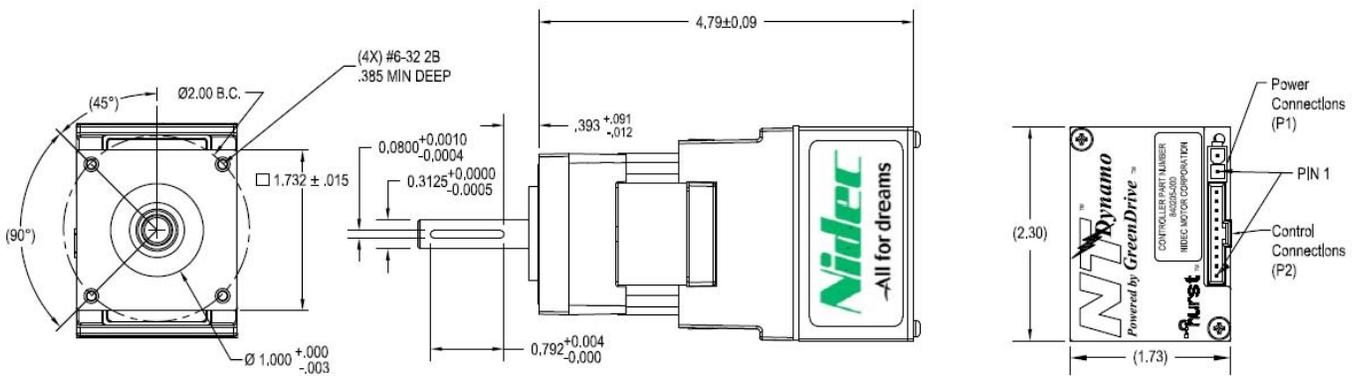


Mechanical Specifications

Dimensional Outline Drawings

Dynamo Size 17 Motor

FIGURE 6 - DYNAMO SIZE 17 MOTOR



CABLES & MATING CONNECTORS

Pin #	Color
1	Red
2	Black

FIGURE 7 - MOTOR POWER SUPPLY CABLE (HURST PART NUMBER: 120016)

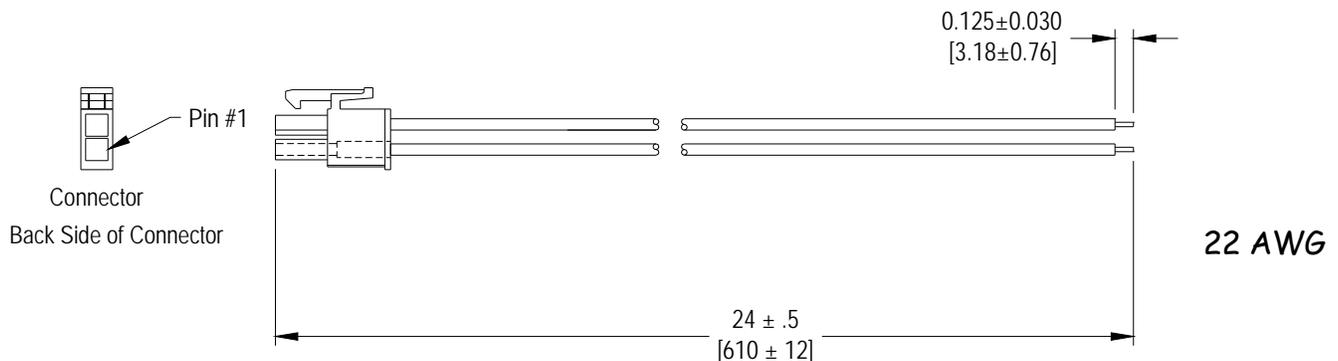


FIGURE 8 - MOTOR POWER SUPPLY MATING CONNECTOR (C1)

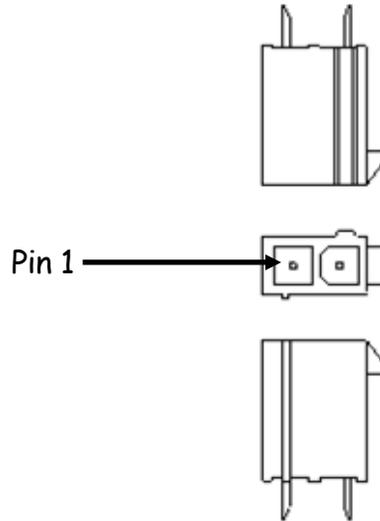


TABLE 3 - MOTOR POWER SUPPLY CABLE REFERENCE

Description	Manufacturer	Manufacturer Part #
Connector	Molex	39-01-2020
Terminal	Molex	39-00-0038 (chain)
	Molex	39-00-0039 (loose)
Control Mating Connector (C1)	Molex	39-28-1023

NOTICE

Minimum Gauge Size is recommended to be 22 AWG or greater.

FIGURE 9 - CONTROL CABLE (HURST PART NUMBER: 120106)

Pin #	Color
7	Blue
8	White
9	Black
10	Red

22 AWG

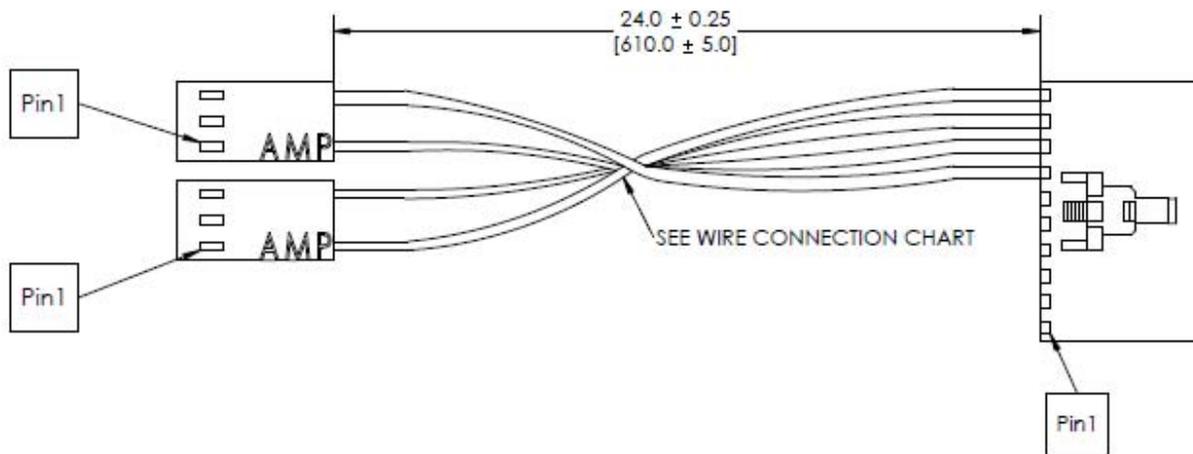


FIGURE 10 - CONTROL MATING CONNECTOR (C2)

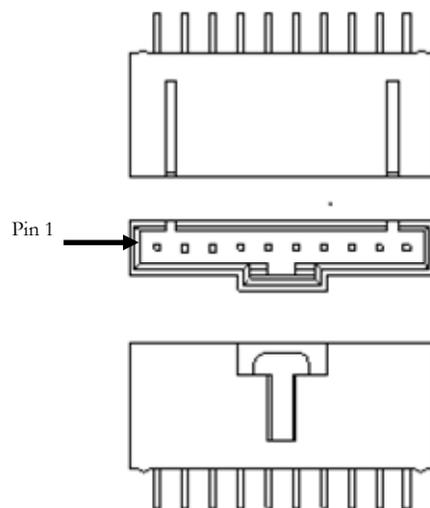


TABLE 4 - CONTROL CABLE REFERENCE

Description	Manufacturer	Manufacturer Part #
Connector	Molex	50-57-9410
Terminal	Molex	16-02-0087 (chain)
	Molex	16-02-0103 (loose)
Connector	TE Connectivity	87499-6
Terminal	TE Connectivity	87523-5
Control Mating Connector (C2)	Molex	70543-0009

NOTICE

Minimum Gauge Size is recommended to be 22 AWG or greater.