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LIN ENGINEERING
The Step Motor Specialists
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R256 Controller

With built-in 256 Microstepping Driver



RoHS COMPLIANT

User Manual
Version 1.20

Lin Engineering
16245 Vineyard Blvd., Morgan Hill, CA 95037

Thank you for purchasing the R256 Controller with Microstepping Driver. This product is warranted to be free of manufacturing defects for one year from the date of purchase.

PLEASE READ BEFORE USING

Before you begin, ensure there is a suitable DC Power Supply. **Do not connect or disconnect the DB-9 cable while power is still being applied to the controller.** This will damage the board. Under any circumstances, do not exceed +40 VDC.

DISCLAIMER

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This manual revision, is provided for distribution with R256 controllers sold through Lin Engineering

Special Symbols



Indicates a WARNING and that this information could prevent injury, loss of property, or even death (in extreme cases).

R256 User Manual

Product: R256
Version: 1.20
Date: 3/22/2018

Version History		
Version	**Date**	**Description of Changes**
1.00	01/11/2006	New User Manual
1.01	08/18/2006	Typographical errors
1.02	01/31/2007	Standardization of User Manuals
1.03	10/26/2007	Updated description of RMS vs Amp Peak current, and explanation of I/O's
1.04	12/14/2007	Updated designer's kits, descriptions of connection & HyperTerminal
1.05	4/3/2009	Added new RS485-232 card hook up information
1.06	9/16/09	Updated image for LED connection.
1.07	10/29/2009	Added full step as a resolution option.
1.08	9/23/2014	Replaced Hyper Terminal with LinCommand
1.09	5/16/2016	Updated links and specs
1.20	3/22/2018	Update name and logo

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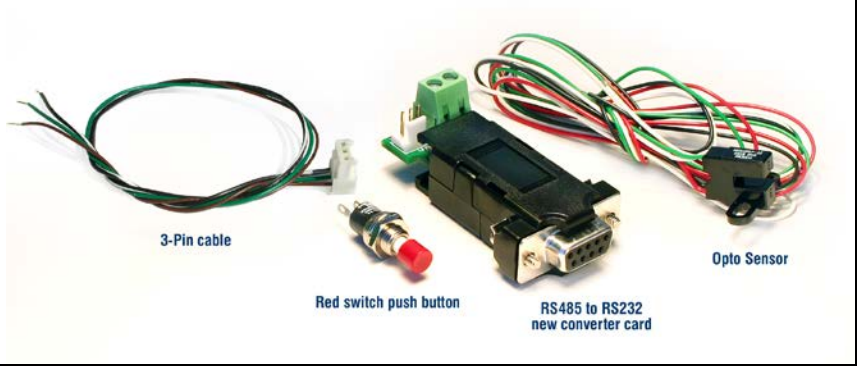
1. FEATURES

- Controller with built in Microstepping Driver
- Operates from +12V to 40V
- Single 2 wire bus links together up to 16, R256 controllers (RS485 bus)
- 2.0 Amp Chopper (PWM) Driver
- Full step, 1/2, 1/4, 1/8, 1/16, 1/32, 1/64, 1/128, 1/256 step resolution
- Stand alone operation with no connection to a PC
- Execution Halt pending switch push button
- Pre-wired for Opto Switch inputs
- Homes to an Opto or Switch closure with a single command
- Fully programmable ramps and speeds
- Two digital I/O and two fixed input channels
- External switch for selectable addresses
- Software selectable "Move" and "Hold" currents
- Hold Current automatically selected upon move completion
- Simple DB9 connection

Designer's Kit with USB communication

Here is the list of components if you have purchased the optional Designer's Kit: • USB to RS485 converter card • A switch push button • Opto Sensor • A USB 6 foot long cable Lin part number: USBKIT	

Designer's Kit with RS232 communication

Here is the list of components if you have purchased the optional Designer's Kit: • RS485 to RS232 converter card • A switch push button • Opto Sensor • A 3-pin cable (optional usage) Lin part number: RS232KIT	

Default Settings

Function (command)	**Description**
Running Current (m)	30% of 2.0 Amps (0.60 Amps)
Holding Current (h)	10% of the max current of 2 Amps
Step Resolution (j)	256x
Top Velocity (V)	305175 PPS (microsteps/sec)
Acceleration (L)	L=1000, 6103500 µsteps/sec^2
Position	0
Microstep smoothness (o)	1500
Outputs (J)	Both are turned off, J0
Baud Rate	9600 bps

Table 1: Default Settings

2. ELECTRICAL SPECIFICATIONS

Supply Voltage: +12 to +40 VDC
Peak Current: 0.1 to 2.0 Amps

Digital I/O Specifications

Number of I/O	2
Number of Inputs	2
Input Voltage	+0 VDC to +5 VDC (0 to 24V tolerant, but 5V recommended)
Input Current	700 mA
Pull-up Resistors	10k Ω
Protection	Static Protection to the microprocessor
LED output	(Pin 9) max of 20mAmps, with 200 ohm internal resistor

3. OPERATING SPECIFICATIONS

Maximum Step Frequency	2^24 (PPS) or 16.7MHz
Operating Temperature Range	0° to 50° C
Storage Temperature Range	-20° to 70° C

Communication Specifications

Interface Type	RS485 (RS232 or USB with a converter card)
Baud Rate	9600, 19200, or 38400 bps
# Bits per character	8 Data
Parity	None
Stop Bit	1
Flow Control	None

4. MECHANICAL SPECIFICATIONS

Size: 1.932” x 2.192” x 1.228” (49.07 mm x 55.68 mm x 31.19 mm)
Weight: 3.6 oz (100 gm)
Mounting: Four #6-32 screws, 1.622” x 1.992” (41.20 mm x 50.60 mm)
Cover: Aluminum, Anodized
Plate: Aluminum, Hard Anodized
Color: Black exterior

Dimensions

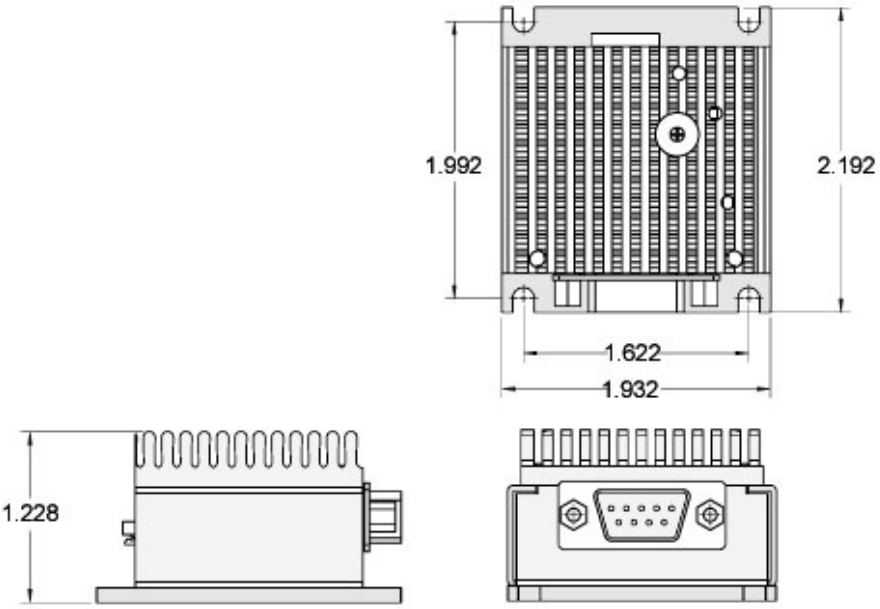


Figure 1: Dimensions Diagram

5. PIN ASSIGNMENTS

A DB-9 female connector cable receives power and provides the control connections for the R256 Controller. The DB-9 cable has a 3 pin connector provided for the converter card in order for the controller to communicate with the PC via RS232 or USB. The remaining 6 wires are for power & controls, allowing the user to solder and program the switch push button and the Opto Sensor, enabling several options. The I/O's will allow for options such as solenoids, relays, opto isolators, LED's and many other input and output connections. See *Table 2* below for details.

Pin #	Color	Function	Input*
1	**Red**	+V (Main Power In)	
2	**Black**	I/O	1
3	**Brown**	RS485B (-)	
4	**Black/□White□□**	RS485A (+)	
5	**Orange**	Switch Closure to GND (IN)	4
6	**Green**	GND (-V of main power in)	
7	**White**	Opto Sensor Phototransistor (IN)	3
8	**Blue**	I/O	2
9	**Yellow**	Opto Sensor LED (Power Out)	

Table 2: Pin Assignments

*Inputs are labeled 1, 2, 3 and 4 for programming the 'Halt' and 'Skip' Commands.

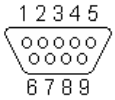


Figure 2: DB-9 Female Cable Connector (When viewing R256 DB-9)

Connecting to the USB485 card

R256 pin#	R256 color	*USB485pin#
4	Black/White	1 (RS485A)
6	Green	2 (GND connect to Power Supply Ground)
3	Brown	3 (RS485B)

Table 4

*Where Pin #1 is located here:



RS485 Connection View

Figure 4

The USB485 converter card does not require power (it receives power from the PC). Power is still needed for the R256 controller/driver.

Connecting to the RS232 card

See Section 11(Appendix B) for connecting to old non-RoHS version, using a red 4-pin connector

R256 pin#	R256 color	*RS232 card pin#
4	Black/White	1 (RS485A)
6	Green	2 (GND connect to Power Supply Ground)
3	Brown	3 (RS485B)

Table 3

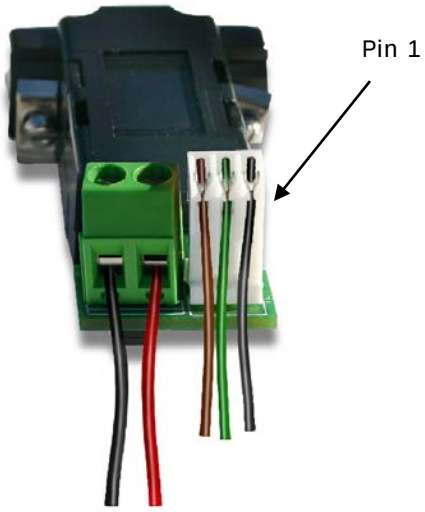


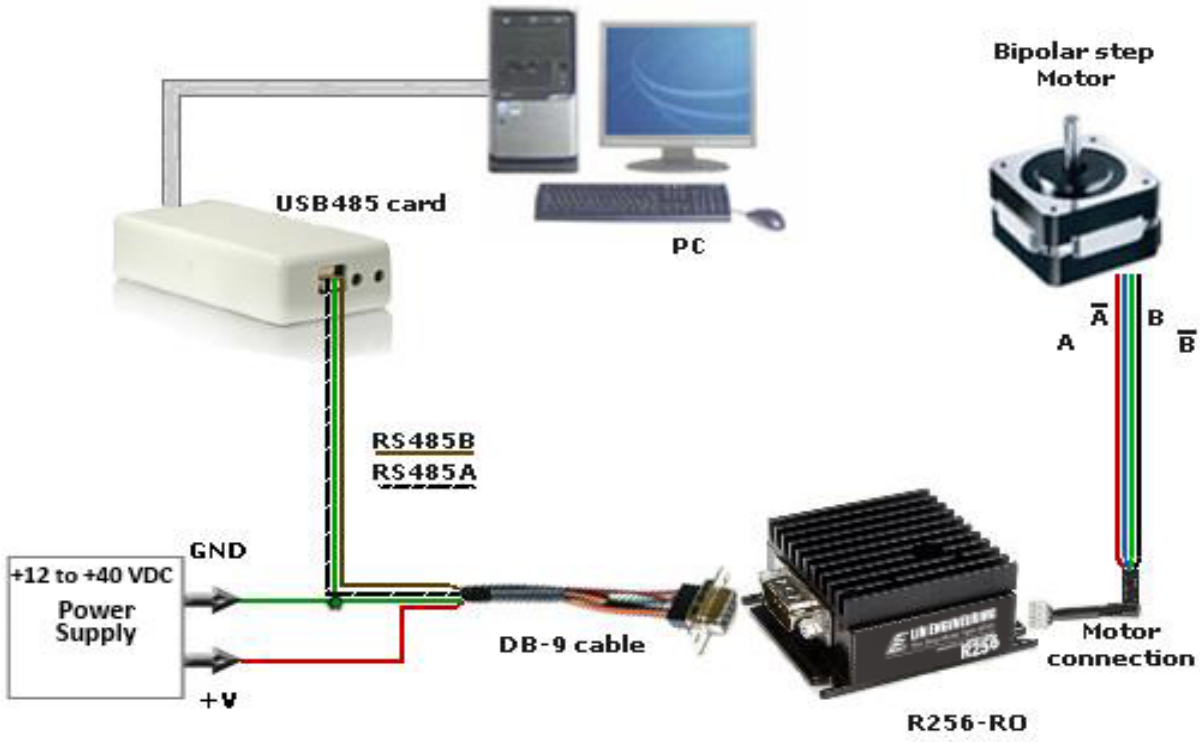
Figure 3

6. CONNECTION SPECIFICATIONS

Quick Start

DO APPLY POWER UNTIL EVERYTHING IS CONNECTED.

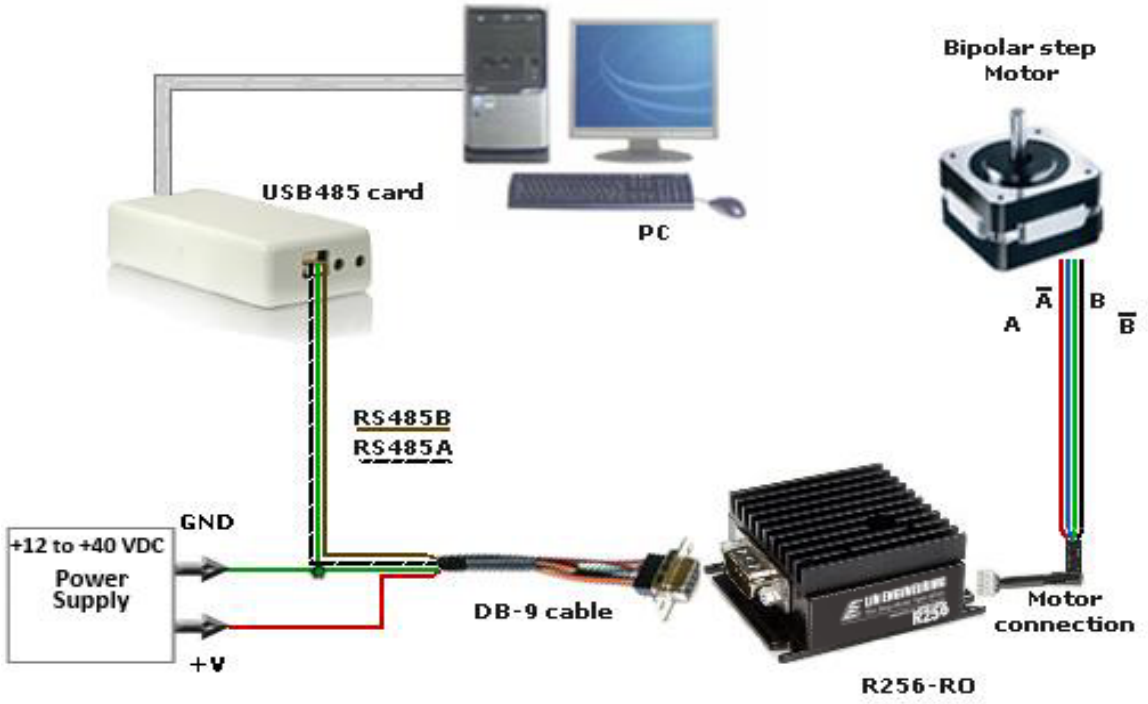
USB-485 converter card



(Figure 6)

1. The USB485 converter card connects to the R256 using the DB-9 cable that is provided to you. The 3-Pin connector is placed onto the converter card.
2. You can refer to the pin assignments on pages 7 and 8.
3. Your power supply will be connected to the R256 controller/driver directly. The USB485 card is powered via the PC. **R256's pin1, Red wire is +12 to +40 VDC, pin 6, Green wire is Ground.**
4. The motor is connected to the R256 using the other cable that is provided. It is a white 4-pin connector. The Red wire is A, Blue is A Bar, Green is B, and Black is B Bar.
5. Connect the USB485 card to your PC using the USB cable provided to you. You can download the driver for the USB485 from this link: USB485 Driver
6. Turn your power supply on and follow instructions for using LinCommand.

RS232-485 converter card



(Figure 5)

1. The RS232 converter card connects to the R256 using the DB-9 cable that is provided to you. The white 3-Pin connector is placed onto the converter card.
2. Your power supply will be connected to the RS232 card where the green header is located. **+ is for +12 to +40VDC, - is for the Power Supply Ground.**
3. You may refer to the pin assignments on pages 7 and 8.
4. The 3-pin connector has a green wire for ground. Tie this to power supply ground.

5. The motor is connected to the R256 using the other cable that is provided. It is a white 4-pin connector. The Red wire is A, Blue is A Bar, Green is B, and Black is B Bar.
6. Connect the RS232 card to your PC using a standard male to female DB-9 cable.
7. Turn your power supply on and follow instructions for using LinCommand.

Mating Connectors

A mating D-Sub connector and crimp style connector are provided.



(Fig 7)
Part # 90-044 is the DB-9 cable with 3-pin header for communication
See page 8 for pin assignments.



(Figure 8) The table to the right depicts the function
Part # 90-018

Color	Function
Red	A+ Phase
Blue	A- Phase
Green	B+ Phase
Black	B- Phase

Table 5

7. CONFIGURING AND CONTROLLING THE R256

LinCommand Setup
For more detailed instructions, please refer to the LinCommand Manual.

Follow these steps to set up and use LinCommand:

Note: If LinCommand has not been installed on your computer, you may download the program in 32 Bit or, 64 Bit, from one of the below links. After downloading, navigate to the 'Setup' file and double click 'Setup' to install.

LinCommand 32 Bit
LinCommand 64 Bit

1. After installation, double click on the LinCommand icon , to launch the LinCommand program.
2. Choose R256 from the drop down box and then click [OK].
3. LinCommand opens in 'Normal' mode with a GUI interface for controlling the stepper motor. For Advance mode skip to step 8 below.
4. To continue in the 'Normal' mode, choose your COM port, baud rate, and controller address (See Figure 9) and then click [Connect],
   Note: if you are using the USB485 converter card, first download driver files for the USB485
5. Choose the 'Motor Settings' tab. Set the Run Current*, Hold Current, Step Resolution,

Velocity, and Acceleration then click [Add Settings to Queue].

*** CAUTION** Do Not Exceed Motors Peak Current or, Damage to the Motor and Controller Could Result! See "**Setting the Current**" on following page.



6. Do**ub**le click on the "**Click Here to Add Command**" to bring up the motor control menu.
7. For a more instructions, please refer to the LinCommand Manual.
8. To operate in the 'Advanced mode', Choose 'Options' and select 'Advanced mode'.
9. Select your COM port and baud rated and then click [Connect].
10. Enter command strings on one of the 7 lines in the 'Send' window and click 'Send' to send command line to the controller.
11. For a complete list of commands and their definitions refer to the R256 Commands manual.

Example command: /1A10000R

- This will run unit #1 to the Absolute position 10000
- You can check the address of your driver by checking the dial at the top of the driver. (See the following page for Changing the Address)
- A full list of commands is available in the Silverpak 17C / R256 Command List
- Most common commands to change are:
    - Step resolution (/1j2R sets R256 for half stepping)
    - Velocity in pulses/sec (/1V1000R sets speed to 1000 pps)
    - Run current (/1m30R sets the run current to 30%)
    - Hold current (/1h10R sets the hold current to 10%)
    - Move the motor (/1P800R turns the motor 2 revs if half stepping 1.8°)

Responses:
?/0@ indicates good command and that it was received correctly
?/0b indicates bad command
?/0C indicates that the command is out of range
?/0` indicates that the command is terminated
?/0`a Overflow

Setting the Current

CAUTION! DO NOT SET THE CURRENT 1.4 TIMES ABOVE THE MOTOR'S RATED CURRENT.

In order to set the correct current for your motor, you must program the specified current in LinCommand

Current is set based on the Maximum amount of current the controller board can output, which is 2.0 Amps Peak. Since all drivers only speak in terms of Amps Peak current, we must translate from the motor's rated current (Amps/Phase or Amps

RMS) to peak current. Below is a table of how much current will be applied to your motor for each setting.

Percent		Motor's Current Rating (Amps/Phase)	Driver's Equivalent Current (Amps Peak)
10%	=	0.14	0.20
20%	=	0.28	0.40
30%	=	0.42	0.60
40%	=	0.57	0.80
50%	=	0.70	1.00
60%	=	0.85	1.20
70%	=	0.99	1.40
80%	=	1.13	1.60
90%	=	1.27	1.80
100%	=	1.41	2.00

Table 6: Desired Current

To achieve the equivalent Driver Current (Amps Peak), multiply your motor's rated current by 1.4. See examples on following page:
Motor's Rated Current x 1.4 = Driver Peak Current

Example One:

You have a motor that is rated at **0.85** Amps, 0.85 Amps x 1.4 = ~1.2 Amps Peak. Using *Table 3* we would see that 1.2 Amps is 60% of the driver's maximum output current.

Assuming the R256 Controller is addressed to Number 1, this is what you'd program: **/1m60R**

Example Two:

You have a motor that is rated at **1.0** Amps, and your Controller is addressed to Number 1, this is what you'd program: **/1m70R**

This will set the controller to 1.4 Amps Peak. How did we get 1.4 Amps? → 1.0 Amps x 1.4 = 1.4 A

WARNING!: Setting the Current to a value greater than 1.4 times the Motor's rated current will damage your motor, and may overheat the controller.

Connecting Multiple R256 Controllers

If using the RS232-to-RS485 converter card, daisy chain all four wires: power, ground, RS485+ and RS485- prior to plugging into the converter card.

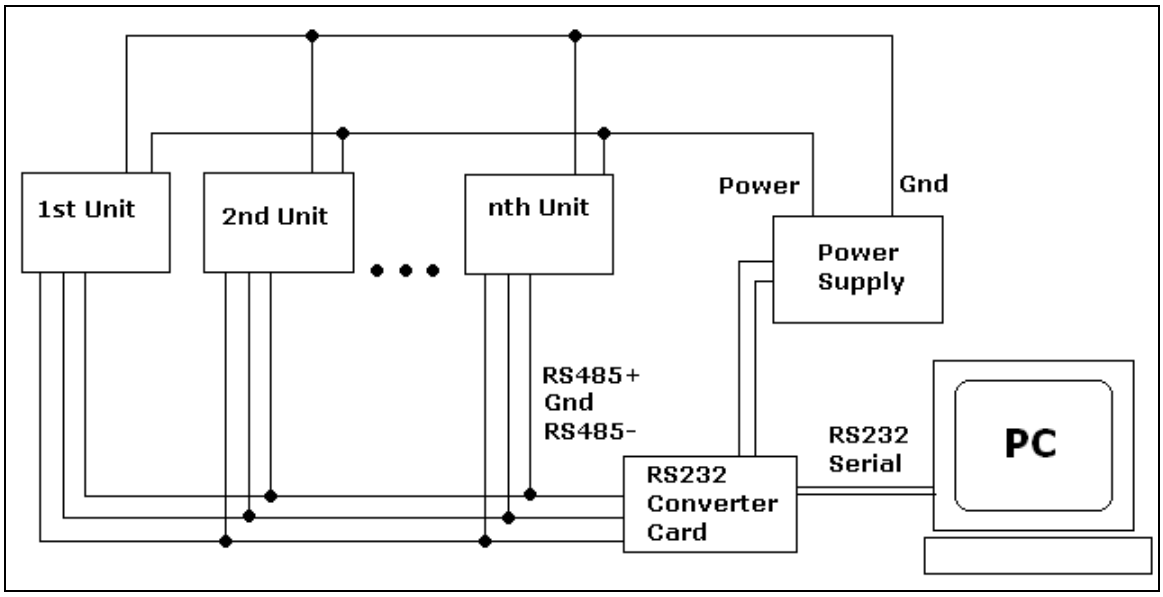


Figure 12: Connection using RS232 Converter Card

If using the USB485 converter card, connect all the power and ground lines on the units to the main power supply. Then daisy chain the RS485+ and RS485- lines prior to plugging into the USB485 card. Be sure to also ground the USB485 card with Pin 2, ground.

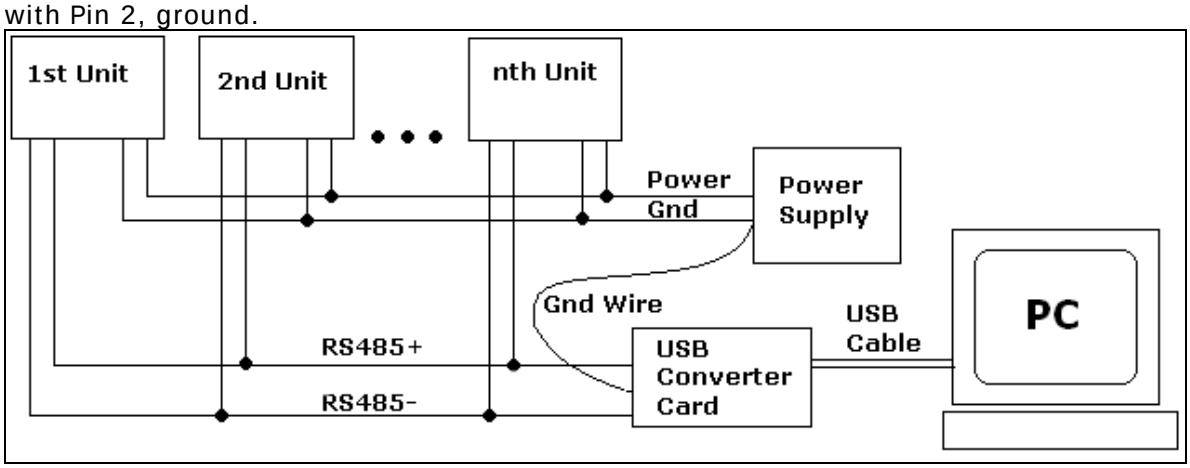


Figure 13: Connection using USB485Converter Card

Changing the Address of the Controller

Use a small screwdriver to turn the dial so the arrow points to the desired Address. Use this number when programming commands. For example, /**1**P1000R



Figure 14: Address Dial

Connecting the Accessory Pieces

If you have purchased the Designer's Kit, there is a Red Push Button and an Optical Sensor included. Follow the schematics below in order to properly assemble accessory pieces.

Push Button

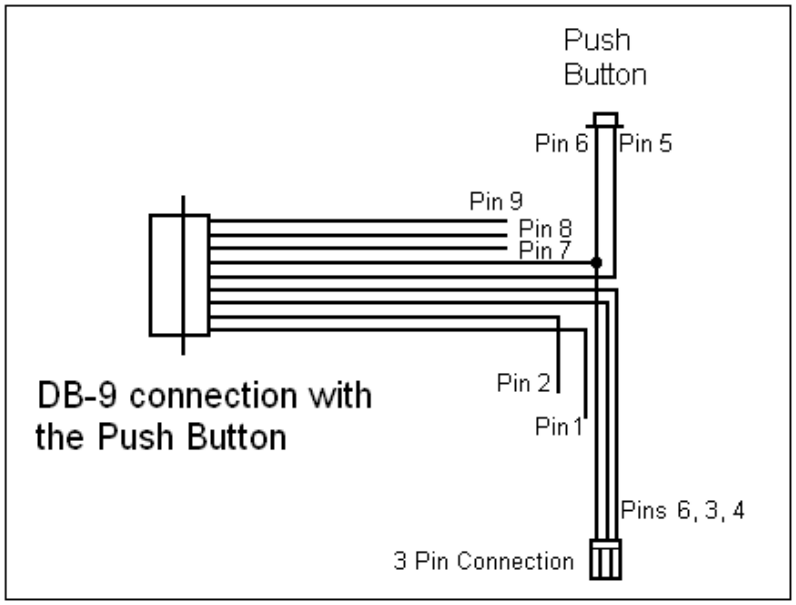


Figure 15: Push Button Schematic

It is best to solder the Push Button to Pin 5 which corresponds to Input 4, and then solder Pin 6 (Power Ground) to the other side of the push button.

Input 1	Pin 2 (Black)
Input 2	Pin 8 (Blue)
Input 3	Pin 7 (White)
Input 4	Pin 5 (Orange)

Table 7

Any of the four inputs can be connected to a push button. In our example above, pin 5 corresponds to input #4, therefore, if you want to program the motor to wait until this button is pressed in order to begin movement, your program would look something like this:

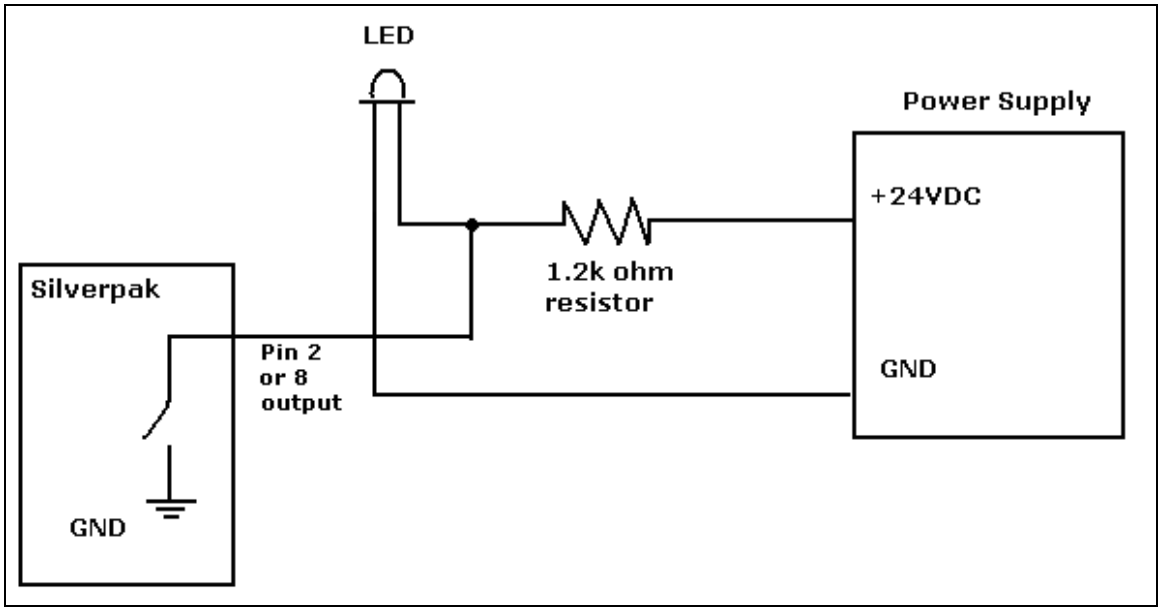
/1H04P50000R

H04 means to Halt until it sees a low, or 0, on input #4
P5000 move the motor in the positive direction by 5000 steps
R is to run this string of commands

The motor should send the command P5000 once the button has been pressed, otherwise, it will continue to wait at "H04"

LED or other output

The two I/O lines, pins 2 & 8, can drive an external device such as solenoids, LED's, or switches. The bidirectional I/O's are switches that ground internally, and therefore need to be connected to the +V of the power supply. Below is a recommended connection for lighting an LED with 20 mAmps:



Upon entering command /1J0R, both pins 2 & 8 will output 1 Amps. The 1.2k ohm resistor will limit the current to 20 milliamps into the LED. Select any ohm value to limit your current based on the device that is connected to the output.

I/O's are 24VDC tolerant.

Optical Sensor

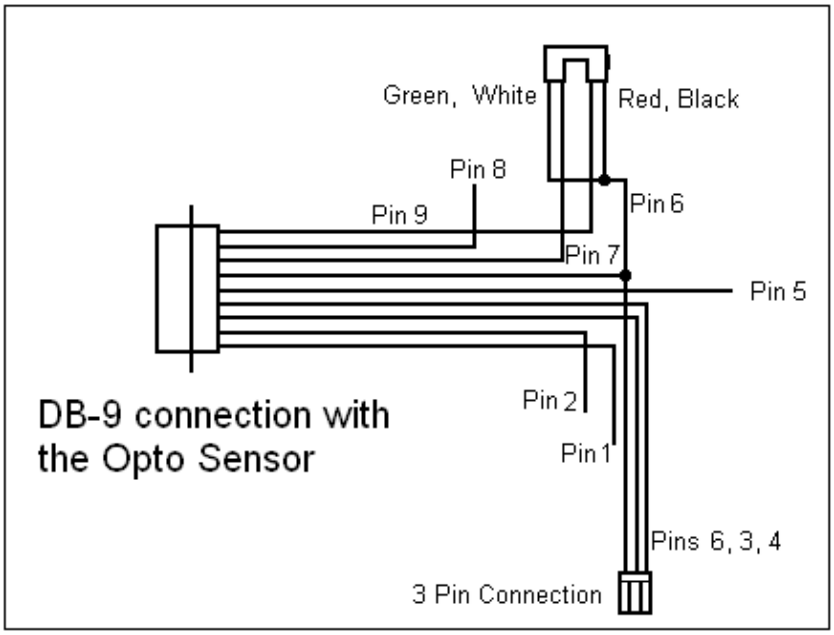


Figure 16: Opto Sensor Connection Schematic

The Opto Sensor uses Pins 6, 7, and 9. Use the following table to solder the corresponding wires.

Optical Sensor	DB9 Cable
Green →	Green
Black →	Green
Red →	Yellow
White →	White

Table 8

In order to program the motor to home towards your optical sensor, simply use the Z command and state the max number of steps you want it to search for home. The unit will either stop at the opto sensor or when it finishes moving your designated number of steps. For example:

/1Z500000R

Motor will take 500,000 steps and stop OR Motor will stop once the optical sensor has been interrupted. Only input #3 can work with the optical sensor.

The LED output on pin 9 can output a max of 20mAmps (200 ohms internal resistor and 5VDC output)

Encoder Usage

The R256 can also be used as reference to home by connecting to an US Digital E2 Encoder. The pinouts are as follows:

Pin Number	Function
1	Ground
2	Index
3	Channel A
4	+ 5 VDC
5	Channel B

Table 9

The E2 encoder requires a separate +5 Volt power supply, as the R256 controller cannot provide a strong enough source of power.

In order to use the Indexer as a reference to home, connect Pin 2 from the encoder to one of the inputs on the controller. From the controller's side, for best results use Pin 5, the switch closure to ground.

In addition, use a pull-down resistor (10k Ω) to ensure that the controller will recognize the difference between high and low (4.85V and 0.5V).

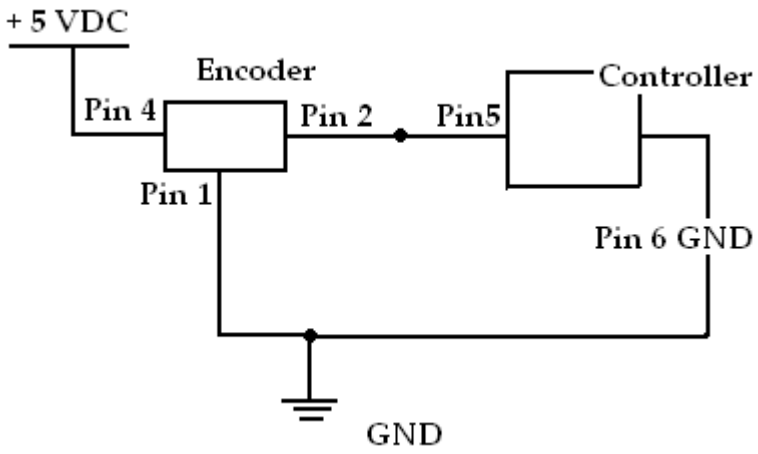


Figure 17: Encoder Pin Connection Schematic

After successfully connecting the encoder to the controller, now you can program the controller to run continuously. The motor will stop movement when the indexer goes high. This will send the high signal to Pin 5 on the controller.

If using channel 1, use this command to start the homing routine:

/1P0R

8. MOTOR CONNECTIONS

Step Motors have 4, 6, or 8 wires. To better understand how to connect your step motor with your R256 Controller, follow the Figures below for the corresponding motor. NOTE: The dots indicate the starting position of the wires when wound.

4 Lead Wire Motor Connection

Connect one set of windings to the A terminals. Connect the other set of windings to the B terminals. If the set of windings is unclear, take a pair of wires; use an ohmmeter to check for continuity. When you find the first two wires that have continuity, connect it to the A terminals. Connect the other two to the B terminals.

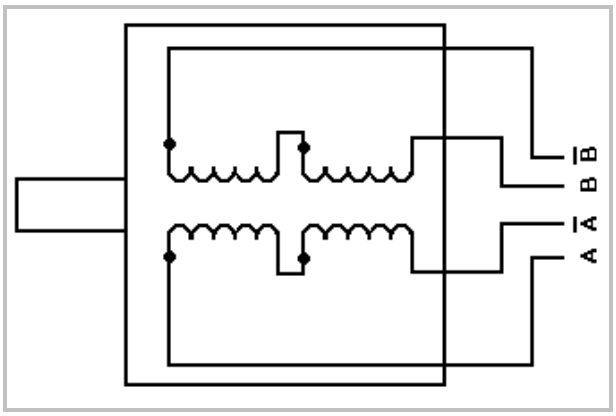


Figure 18: 4 Lead Wire Motor Connection

6 Lead Wire Motor Connection (Half Winding)

Six wire motors can be wound in two ways: Half Winding and Full Winding. Six wire motors contain a center tap on each of the two windings. For a half-winding connection, the center tap and one end of the wires are used.

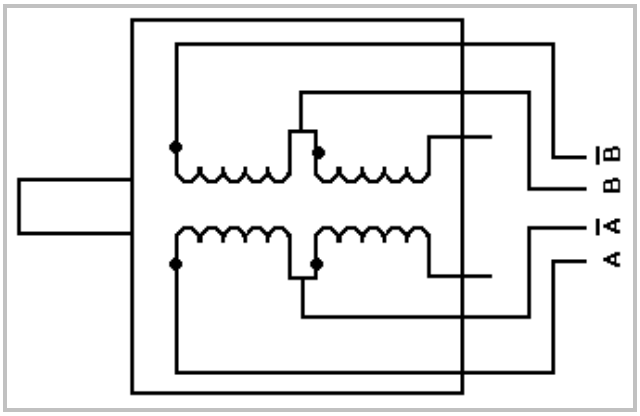


Figure 19: 6 Lead Wire Half Winding Connection

6 Lead Wire Motor Connection (Full-Winding)
For a full winding connection, use both end wires, the center tap is ignored. (NC: No Connection).

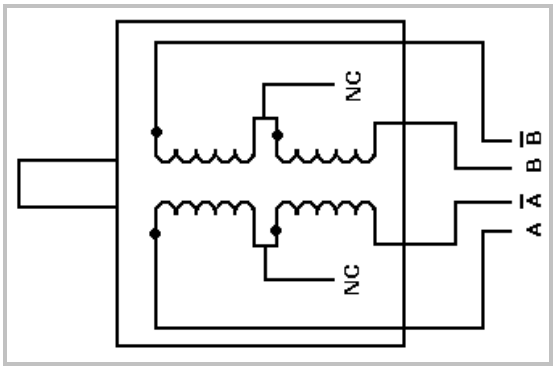


Figure 20: 6 Lead Wire Full Winding Connection

8 Lead Wire Motor Connection (Parallel Connection)
Eight wire motors can be connected in two ways: Parallel and Series. When in parallel, the wires are simply connected such that the beginning of each winding are connected together.

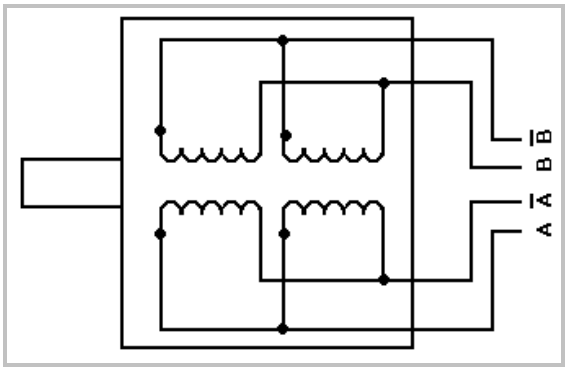


Figure 21: 8 Lead Wire Parallel Connection

8 Lead Wire Motor Connection (Series Connection)
Be sure to set the drive current to exactly half of the motor's rated parallel current rating when using the series connection.

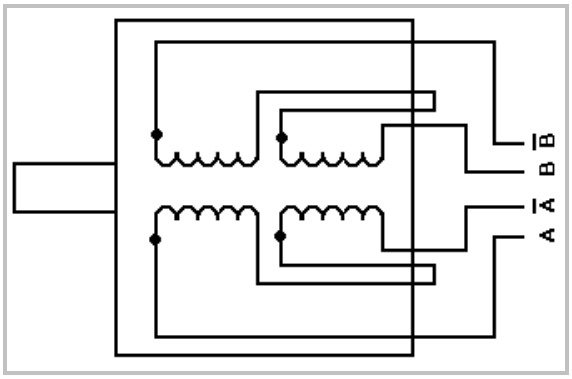


Figure 22: 8 Lead Wire Series Connection

9. Troubleshooting & FAQ

Is the correct COM Port selected? Use an operating system of Windows 98 or higher. Are you working on a Laptop? Sometimes there is a shift in Ground on Laptop Serial Ports. Pin 5 on the Serial Port is Ground. Make sure that this is connected to a true ground.

Is the LED flashing on the R256 Controller? A flashing light indicates it is waiting for Commands and power is OK. Motor shaft should be difficult to rotate.

Check the Converter Card. Use a voltmeter to measure if Power is coming into the card correctly and if power is being supplied to the Controller properly.

Check the LED on the top of the R256 unit. If there is no LED lit, the problem may be the Power Supply, check the connections. If you see one LED that flashes on and off about 5 seconds at a time, then power is OK.

Is the R256 Controller set to the correct Address? Check the Dial on the top of the controller. The arrow should be pointing to the corresponding Address. Make sure that the arrow is not between 2 Addresses. Use a small screw to verify that it clicks in place.

Check the Converter Card. Use a voltmeter to measure if Power is coming into the card correctly and if power is being supplied to the Controller.

Note the description of the following response strings.
/0' indicates that the command is terminated
/0@ indicates good command and that it was received correctly
/0C indicates that the command is out of range
/0b indicates bad command

If the unit is set to the default value of, 256 microsteps. Typing in a position move of /1P200R, would be too small to see movement. It would take 51,200 steps to make one revolution, so try a large value, like /1P100000R

R256 Controller will accept commands, but the Motor will stall in the middle of a command:

This means there is not enough current being supplied to the Motor. Use the m command to change the current, or run the Motor at a Lower Speed (V command). Or, make the motor accelerate slower using the L command.

Halt Command (H01) Issues

There are known issues involving the Halt command (i.e., H01) when stored in memory location zero. Upon power up, the remaining command string after the Halt command might be executed if the user types in a new command. If memory location zero is not being used, the user is advised to always clear everything in memory by typing /1?9. Otherwise, the user may terminate the remaining command string in the buffer by issuing a /1T.

I want to use one of the I/Os to turn on a LED to confirm that the motor has finished moving or moved to a certain position. How do I do it?
To turn on a LED to confirm that the motor finished moving you must use the "J" command in the command list section On/Off Drivers. We are assuming the unit executes the command sent. We cannot detect skipping because the set up is open loop. Example: /1P200J10R, is a position move 200 steps, then turn on driver 2.

What's the minimum and maximum voltage the RS485 to RS 232 Converter Card can handle?
Min and Max voltage levels: 7 to 40 VDC

Using a PLC to communicate with board
After the command, you need to issue a carriage return and linefeed.
Example: /1A1000R (absolute position move 1000). After the R, send a 0x0d in hex.

USB Converter card setup
The USB converter card requires a driver installed on your computer. The needed driver can be downloaded from the following link. USB485 Driver

After installation, you should be able to view the converter card if you go to Properties of "My Computer" → Hardware → Device Manager → Ports.



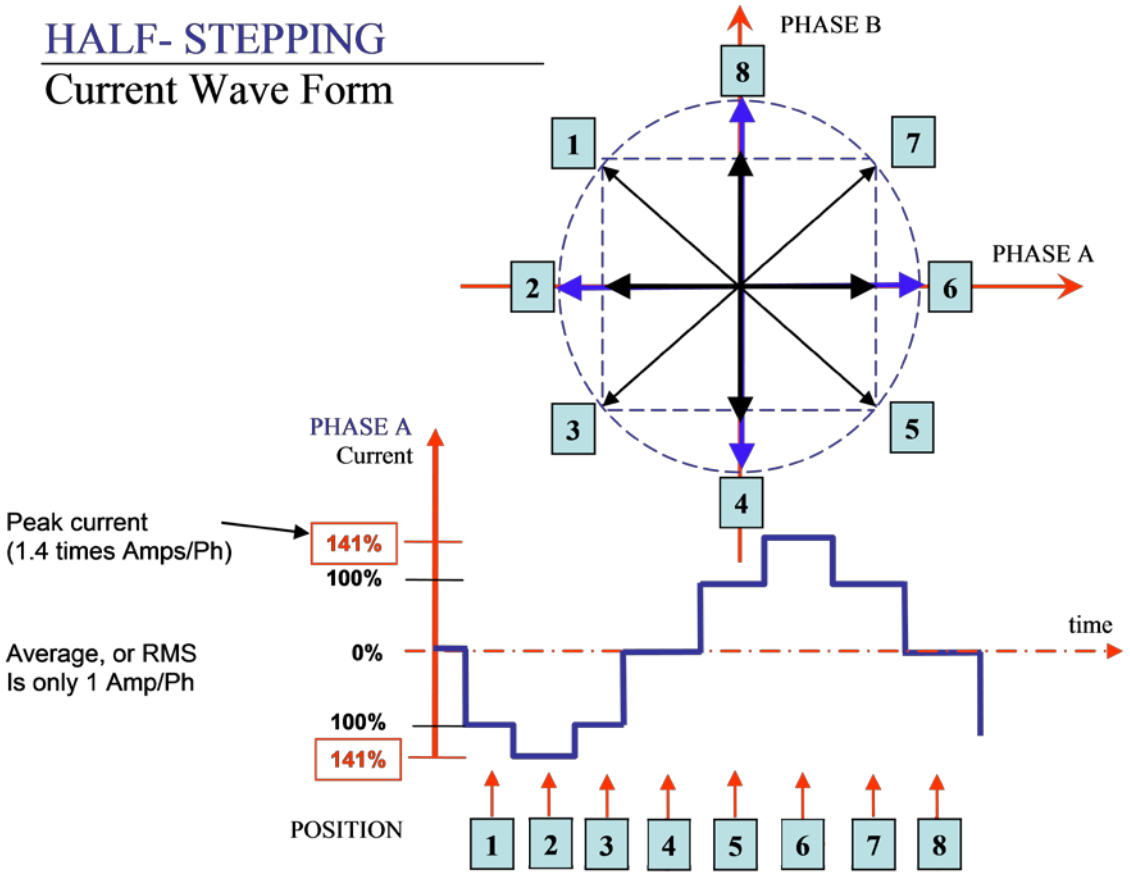
The LED's on the USB485 converter card only light up during sending and receiving of a command.

10. Appendix A

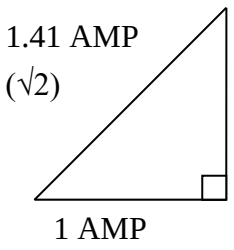
Peak current versus Amps/Phase

Where does the 1.4 times come from? Current is continuously changing when a motor steps. If the motor is rated for 1.0 A/Ph, it may receive 0 Amps, 1 Amp, 1.4 Amps, or anything in between if you are microstepping. For ease of explanation, we will look at the current waveform when we half step, or set the driver/controller to 2x microstepping.

If we take a look at both the A and B phases, and plot on an X-Y chart of when each phase receives current, and how much it receives, it will look like the chart below. Beginning at position 1, Phase A receives negative current, and Phase B receives positive current. Let's assume it is at coordinate (-1, 1).



The position versus time graph just above, plots only the A Phase, following the eight different steps the motor will make. Current is changing with each position. Recall that a negative in electronics simply means reverse direction of current flow.



Take a look at position #7. If we were to draw the arrow at position 7 as the hypotenuse of a triangle, it would look like the triangle to our left. Recall from geometry a 90°-45°-45° triangle is a 1-1-√2 combination. The √2, or 1.4 value is also the radius of the dotted circle shown above. Therefore, during certain steps, Phases A or B will receive 1.4 Amps of current. But the average, or RMS current throughout these 8 steps is only 1.0 Amps. RMS and Amps/Phase is the same meaning.

The 1.4A along this hypotenuse is also known as the 2-Phase On position, since both A and B Phases are "On" and receive current. It is also known as the ***peak current.***

As we see the waveform that's plotted for the A Phase, the highest value on the curve is known as the peak value.

Motors have a rated current, or average RMS value since in operation, the current is continuously changing. The most logical way to describe a rating is to take an average, or RMS (root means squared) value. But drivers understand current in terms of peak current, therefore the conversion is: **Amps/Phase x 1.4 = Amps Peak**

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