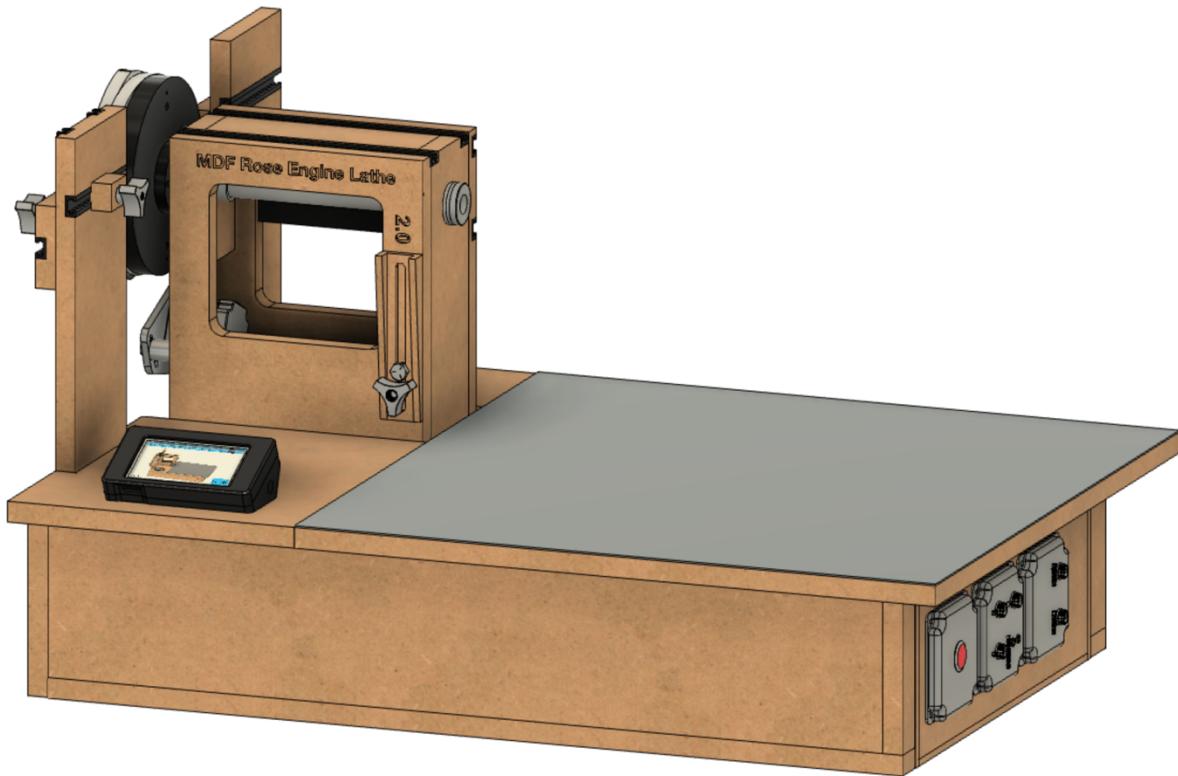


# MDF Rose Engine Lathe 2.0 with Stepper Motor Drive



## Instructions for Building Control System for Multiple Stepper Motors

### Part 3 – Electronics

Version 4.1  
15 June 2022

# **MDF Rose Engine Lathe 2.0**

## **Build Instructions – Control System for Multiple Stepper Motors**

Permission is not granted to manufacture these for sale.

# MDF Rose Engine Lathe 2.0

## Build Instructions – Control System for Multiple Stepper Motors

### Table of Contents

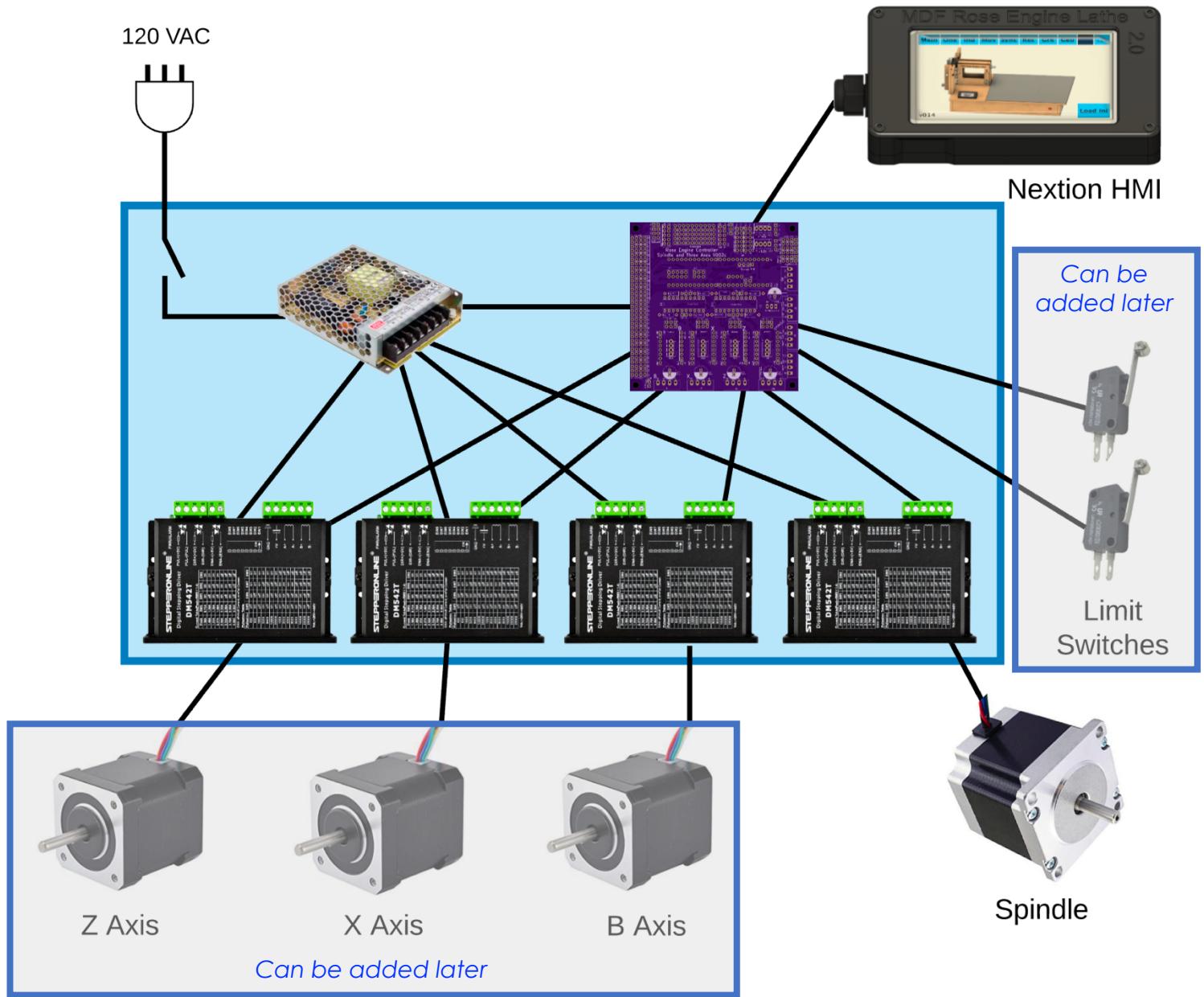
<b>Overview of Connections .....</b>	<b>4</b>
<b>Section 1 – Printed Circuit Board.....</b>	<b>5</b>
Printed Circuit Board versions 002c and 002i .....	6
Printed Circuit Board version 003 .....	15
<b>Section 2 – Power Cables.....</b>	<b>25</b>
<b>Section 3 – Stepper Motor Driver Signal Cables.....</b>	<b>30</b>
<i>Switch Settings.....</i>	32
<b>Section 4 – Nextion Display Signal Cable .....</b>	<b>33</b>
<b>Section 5 – Limit Switch Signal Cables.....</b>	<b>36</b>
<b>Section 6 – Final PCB Steps .....</b>	<b>38</b>
<b>Section 7 – Stepper Motor Cables .....</b>	<b>39</b>
<b>Section 8 – Assembly of the Nextion touch screen Box .....</b>	<b>42</b>
<i>Attach Nextion Display to the Bezel.....</i>	42
<b>Section 9 – System Setup and Program Loading.....</b>	<b>46</b>
<b>Section 10 – Finishing It Up.....</b>	<b>46</b>
<b>Optional Configurations .....</b>	<b>47</b>
<i>Option 1: Less Functional Model.....</i>	47
<i>Option 2: Alternative Stepper Motor Drivers.....</i>	48
<i>Option 3: Different Microcontroller.....</i>	49
<i>Option 4: Different Display .....</i>	50
<b>Document Version History .....</b>	<b>51</b>

# MDF Rose Engine Lathe 2.0

## Build Instructions – Control System for Multiple Stepper Motors

### Overview of Connections

The whole system is shown in the picture below.



The details for how we are building the one you can buy are below. These are documented for our use to ensure consistency, and we are publishing them for anyone who wishes to build their own.

The sequence of activities follows the layout of this document. That was done consciously. Changes to the sequence should be considered strongly before making changes.

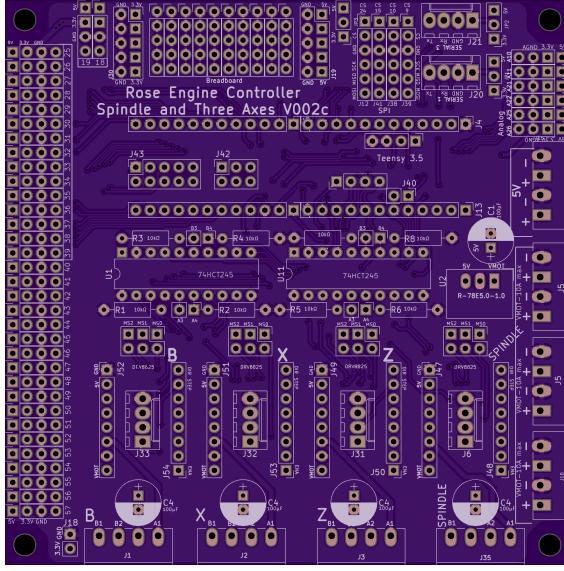
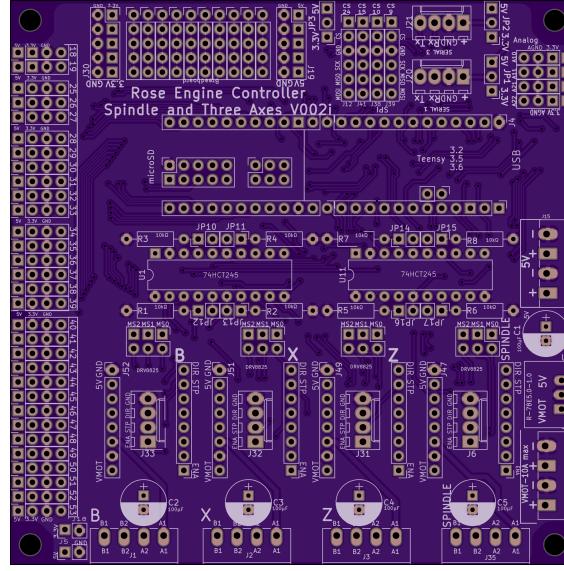
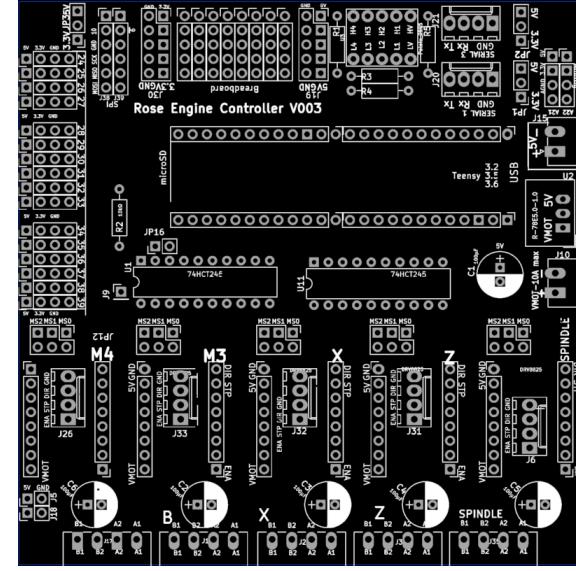
Note: with the v3 board, a 5<sup>th</sup> stepper motor and controller can be added.

# MDF Rose Engine Lathe 2.0

## Build Instructions – Control System for Multiple Stepper Motors

### Section 1 – Printed Circuit Board

Attach the parts to the **Rose Engine Controller Spindle and Three Axes V002c** printed circuit board (PCB) using the instructions below.

		
<b>Version 002c</b>	<b>Version 002i</b>	<b>Version 003</b>
If you are using the <b>Rose Engine Controller Spindle and Three Axes V002c</b> PCB, it will be similar to the <b>Rose Engine Controller Spindle and Three Axes V002i</b> PCB, but the differences are noted in the instructions.	If you are using the <b>Rose Engine Controller Spindle and Three Axes V002i</b> PCB, it will be similar to the <b>Rose Engine Controller Spindle and Three Axes V002c</b> PCB, but the differences are noted in the instructions.	If you are using the <b>Rose Engine Controller Spindle and Three Axes V003</b> PCB, it will also be similar to the <b>Rose Engine Controller Spindle and Three Axes V002c</b> PCB, but the differences are more significant, so there is a separate section for this PCB.
Instructions for this board start on page 6.	Instructions for this board start on page 6.	Instructions for this board start on page 15.

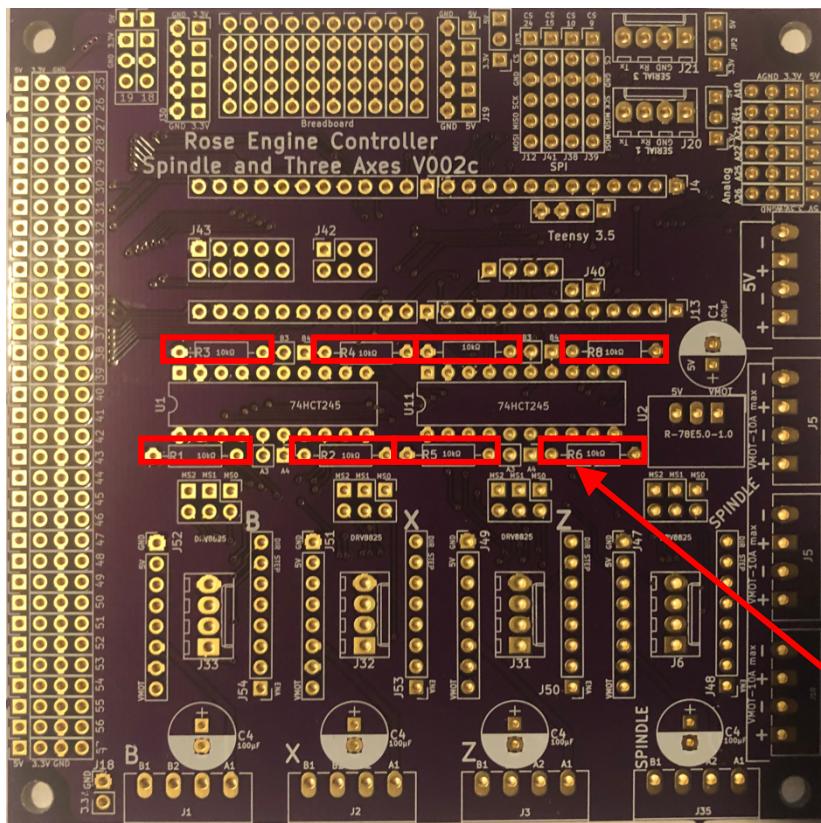
# MDF Rose Engine Lathe 2.0

## Build Instructions – Control System for Multiple Stepper Motors

### Printed Circuit Board versions 002c and 002i

#### Through-Hole Components, part 1

Solder in the resistors as noted below.



101

**NOTE:** the direction in which these are installed is not critical, but I solder them in place the same for each side. Makes it look more dress-right-dress. (My SGT would be happy.)

10 KΩ resistors (8)

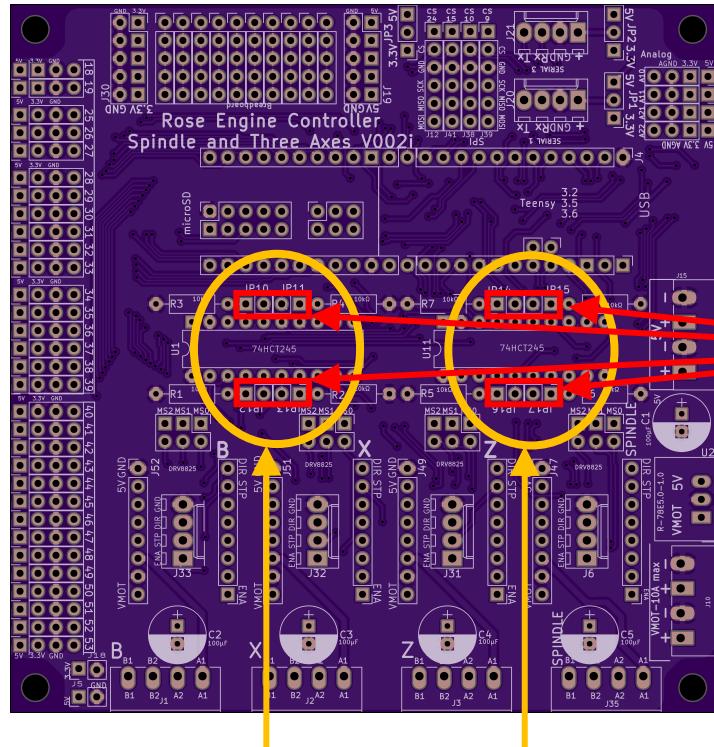
104

# MDF Rose Engine Lathe 2.0

## Build Instructions – Control System for Multiple Stepper Motors

If you are using the version 002i PCB, follow these instructions; otherwise, continue to the next page.

Solder in the 4 headers for bypassing the resistors. These are installed for JP10 – JP17. Add mini-jumpers for JP10, JP11, JP12, & JP13 (for the 74HCT245 on the left side of the board).



**NOTE 1:** Jumpers here when using Serial 1 (default).

**NOTE 2:** No jumpers here when using Serial 3.

**NOTE 3:** No jumpers here when using Serial 1 (default).

**NOTE 4:** Jumpers here when using Serial 3.

Header Connector,  
vertical, 4 pins (1x4),  
2.54mm pin spacing



115

Mini Jumper – Installed across pins in header connector #116.

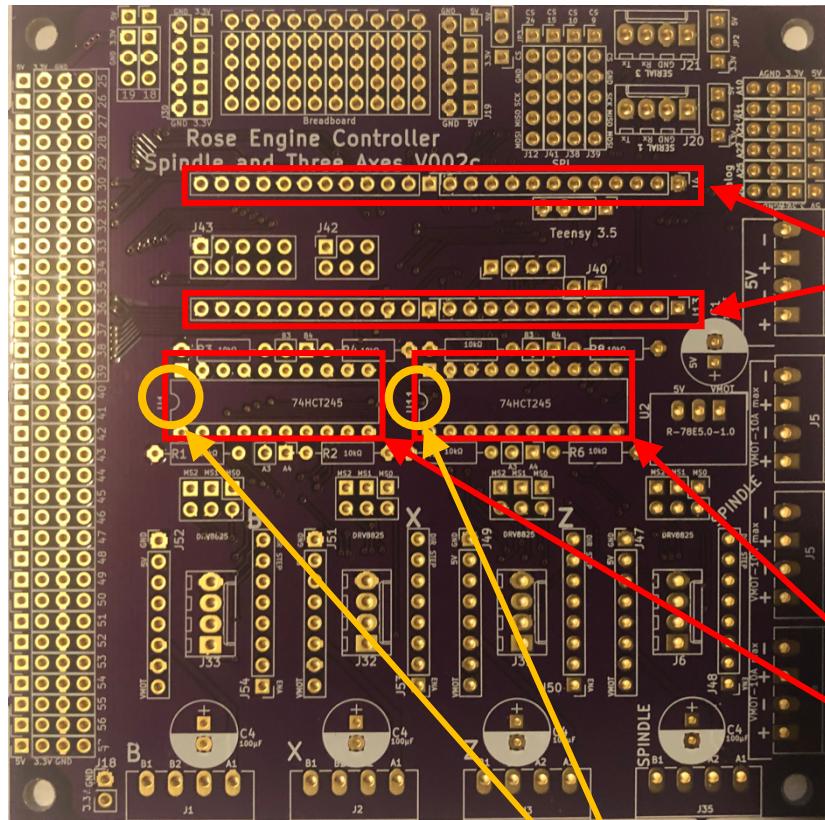
116

# MDF Rose Engine Lathe 2.0

## Build Instructions – Control System for Multiple Stepper Motors

### Headers for Integrated Circuits

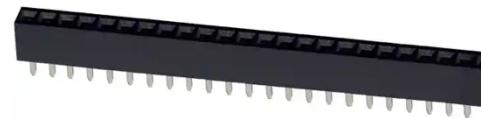
Solder in the 2 headers for the Teensy, and the 2 DIP sockets for the integrated circuits.



Headers (2) for  
Teensy 3.5

**NOTE:** The headers must be at 90° to the circuit board. It is necessary to ensure that they remain perpendicular or the Teensy's pins will not fit into the header pin holes.

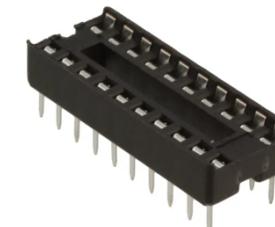
102



20-pin DIP sockets (2)  
for 74HCT245s

103

**NOTE:** Both sockets have direction indicators on them. Ensure they match the direction indicators on the board (the little curved part of the marking on the board). This is to ensure the 74HCT245s are inserted correctly.

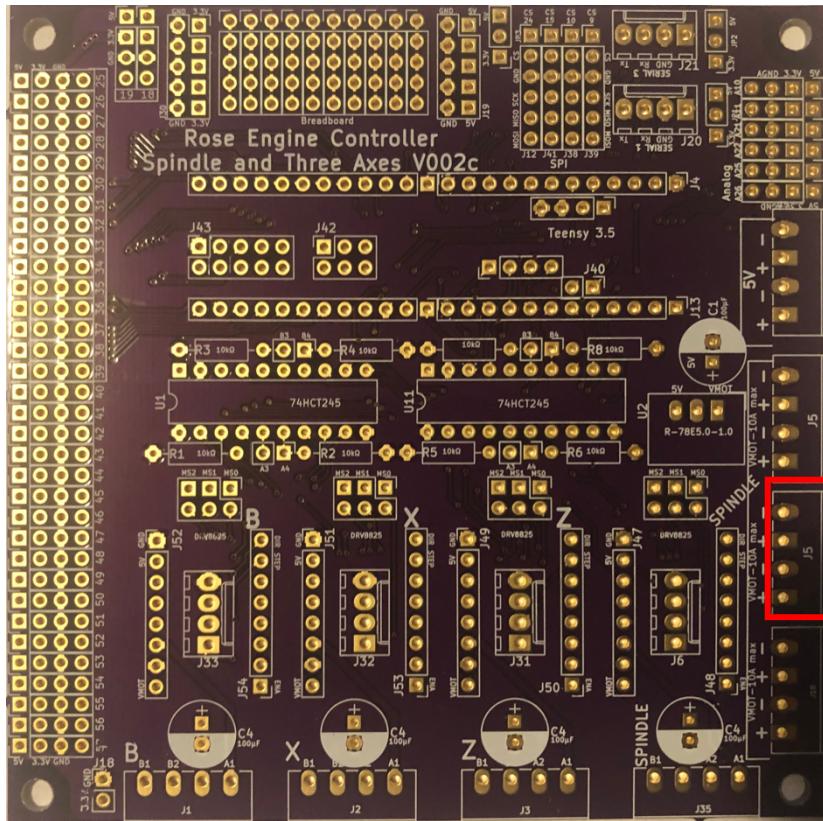


# MDF Rose Engine Lathe 2.0

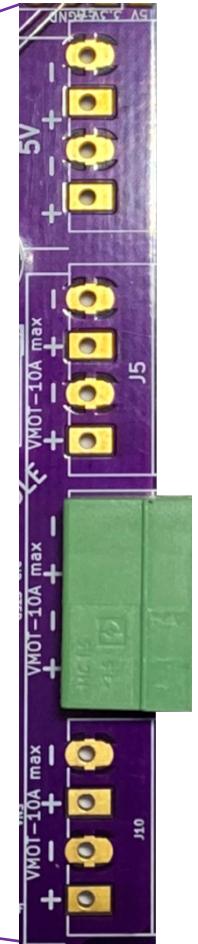
## Build Instructions – Control System for Multiple Stepper Motors

### Power Header Connector

Solder in the power connector as noted below.



Header Connector,  
90 degree, 4 pins,  
3.50mm pin spacing



As  
Installed

**NOTE 1:** Either J5 could be used. Using this one makes later work easier.

**NOTE 2:** On the V002i PCB, this is labelled as J10.

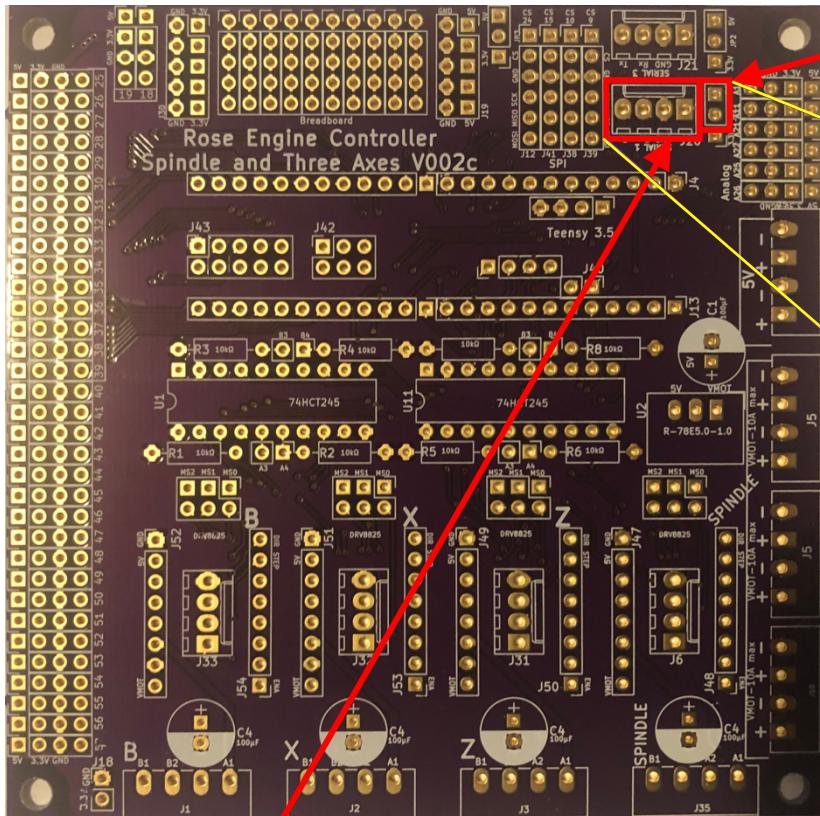
**NOTE 3:** The connector's pins (the side shown above) should point toward the outside of the PCB.

# MDF Rose Engine Lathe 2.0

## Build Instructions – Control System for Multiple Stepper Motors

### Nextion Display Header Connectors

Solder in the power and signal connector for Serial 1 as noted below.

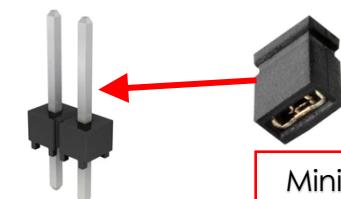


Header Connector,  
vertical, 4 pins,  
2.54mm pin spacing

111

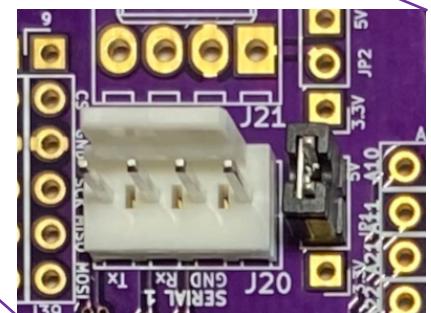
Header Connector,  
vertical, 2 pins,  
2.54mm pin spacing

114



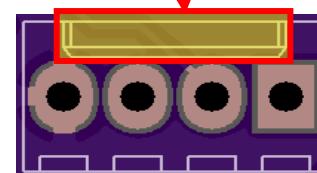
115

Mini Jumper –  
Installed across  
pins in header  
connector  
#114.



As Installed

**NOTE 1:** The plastic tab projecting up from the connector should be aligned with this marking on the PCB.



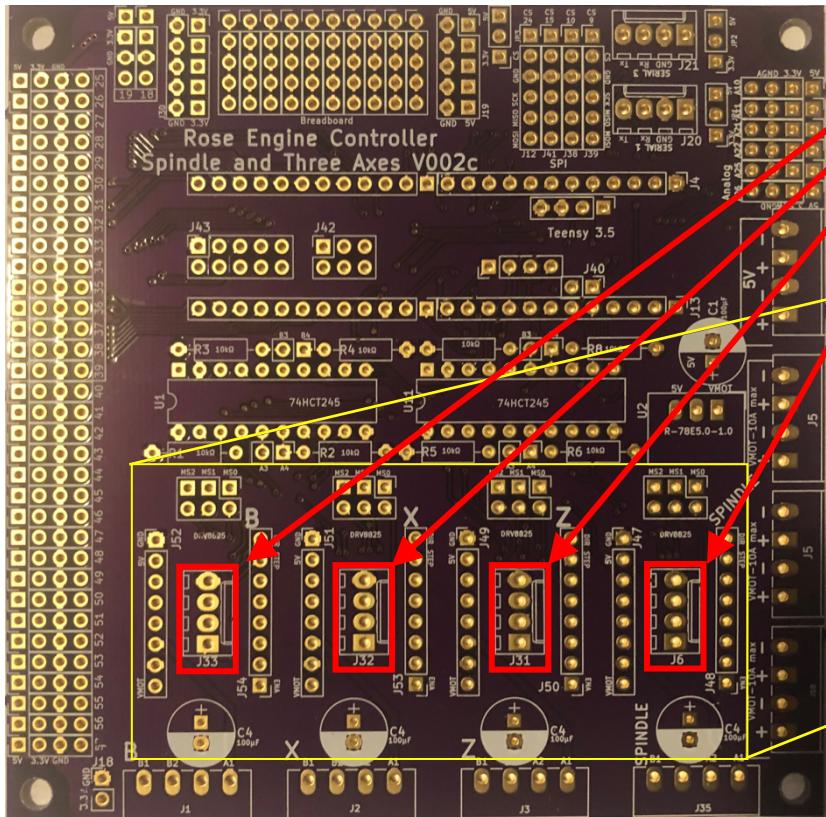
**NOTE 2:** If you are using the V002c PCB, a Teensy 3.6, and a Nextion Intelligent display (or plan to do so), these two connectors are not needed; proceed to the next step.

# MDF Rose Engine Lathe 2.0

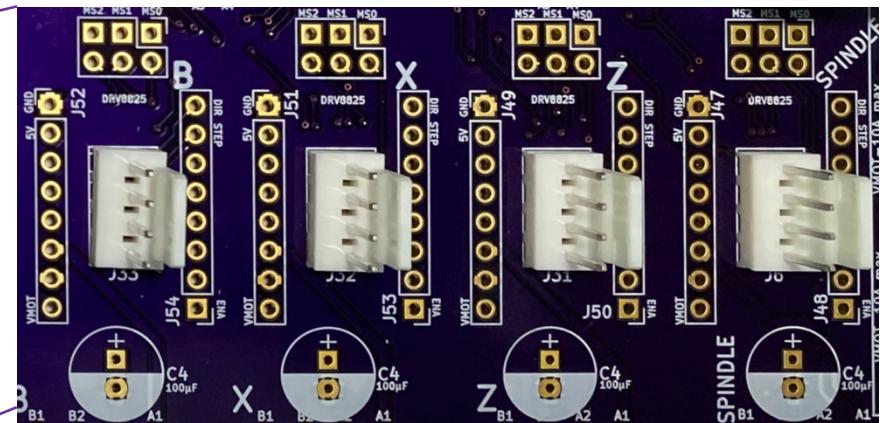
## Build Instructions – Control System for Multiple Stepper Motors

### Stepper Motor Driver Header Connectors

Solder in the stepper motor driver connectors as noted below.

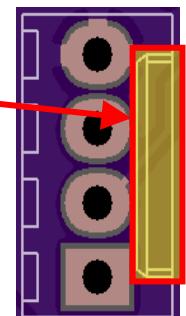
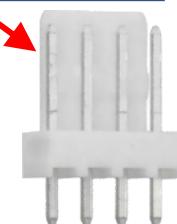


Header Connector,  
vertical, 4 pins,  
2.54mm pin spacing



As Installed

**NOTE:** The plastic tab projecting up from the connector should be aligned with this marking on the PCB.



# MDF Rose Engine Lathe 2.0

## Build Instructions – Control System for Multiple Stepper Motors

### Limit Switch Header Connectors

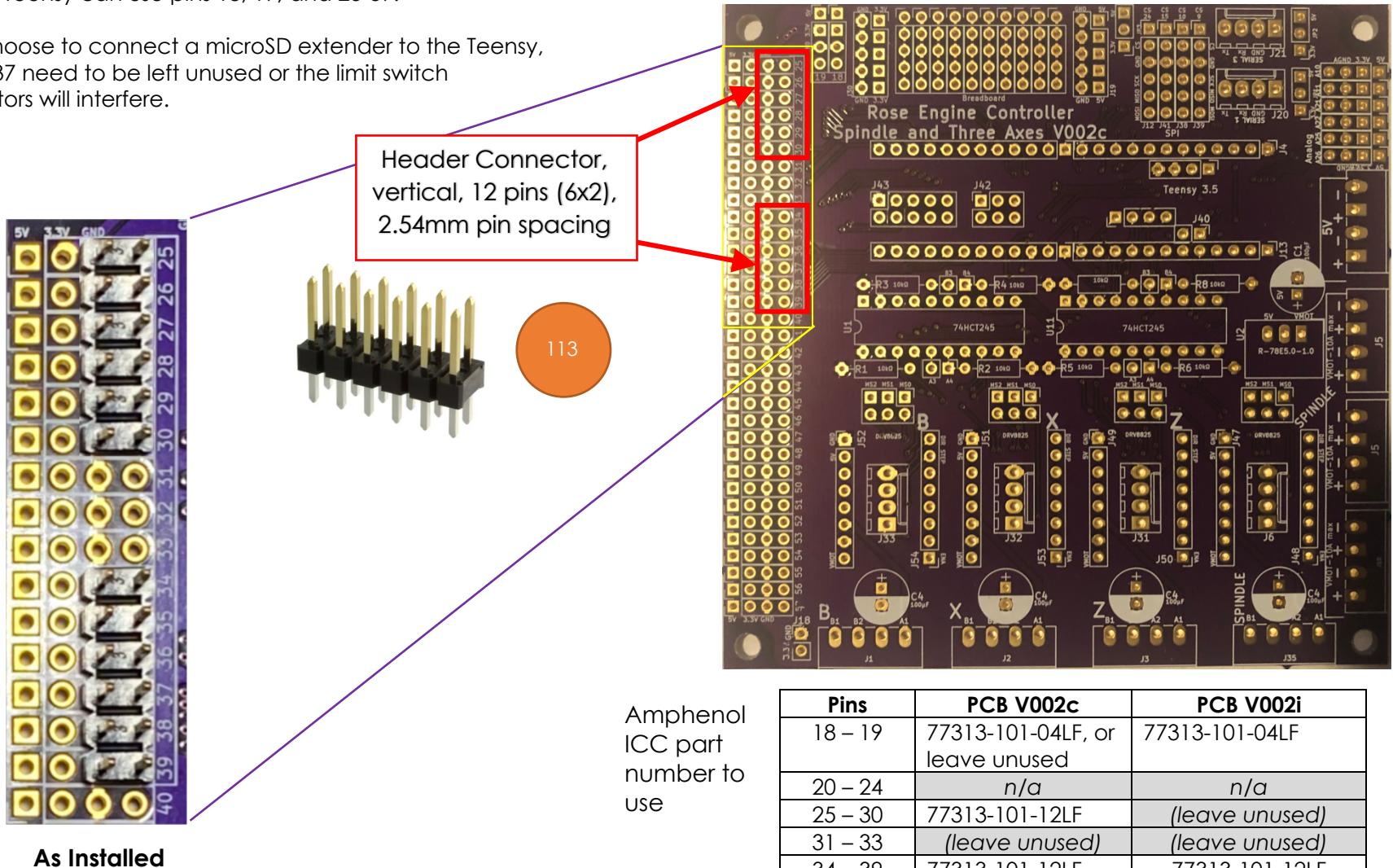
Solder in the limit switch connector pins as noted below.

The original design only used pins 34-39; however, this board and the Teensy can use pins 18, 19, and 25-39.

If you choose to connect a microSD extender to the Teensy, pins 29-37 need to be left unused or the limit switch connectors will interfere.

**NOTE1 :** One connector is used on pins 25-30.

**NOTE 2:** A second connector is used on pins 34-39.

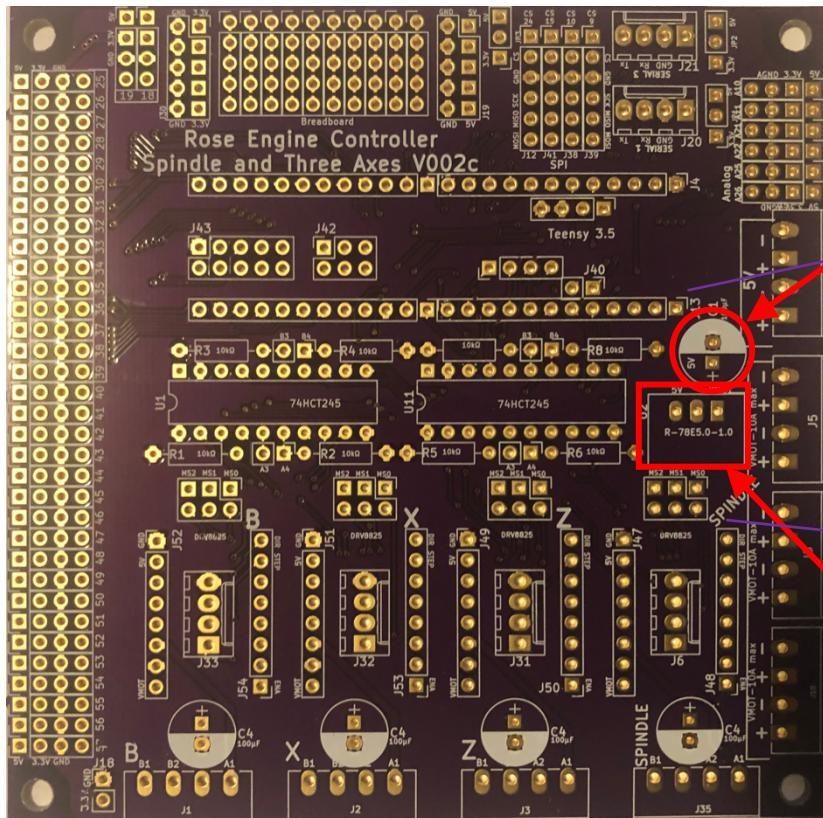


# MDF Rose Engine Lathe 2.0

## Build Instructions – Control System for Multiple Stepper Motors

### Through-Hole Components, part 2

Solder in the components noted below.



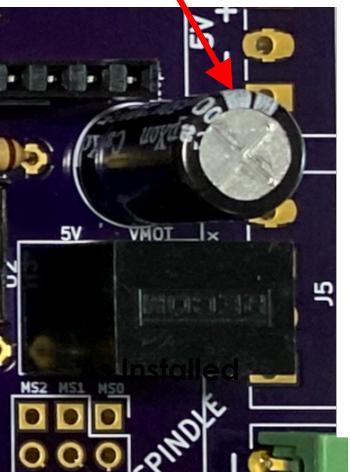
**NOTE 3:** On the V002i PCB, the placement on the board is slightly different, but is marked similarly none-the-less.



105

100  $\mu$ F Capacitor

**NOTE 1:** Be sure the capacitor is set correctly. The negative (-) side goes in the area shaded white.



107

R-78E5.0-1.0 DC  
DC Converter

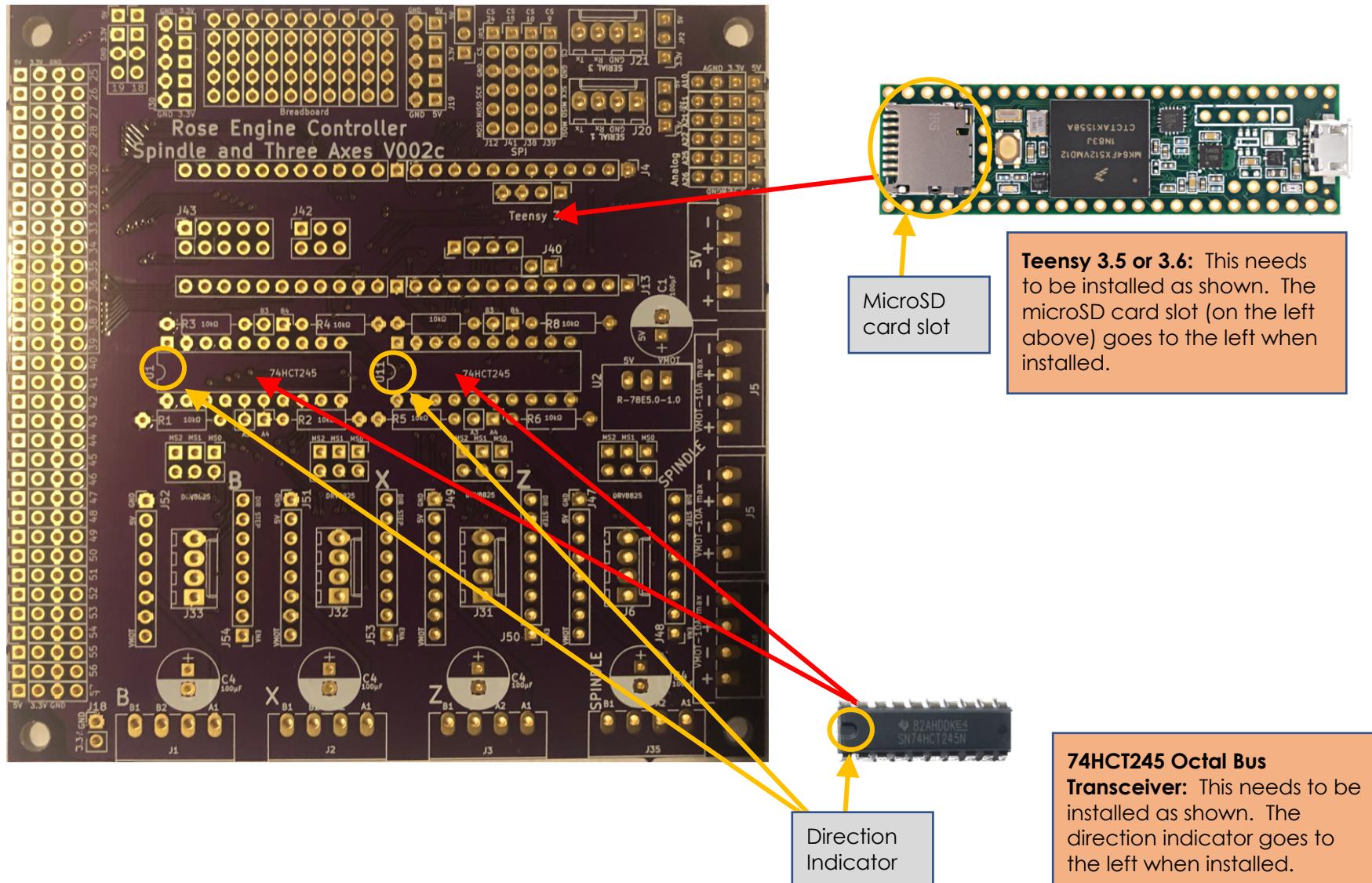
**NOTE 2:** The DC converter should fit over the box printed for it on the board.

# MDF Rose Engine Lathe 2.0

## Build Instructions – Control System for Multiple Stepper Motors

### Install Components

Install the components as noted below.



**Teensy 3.5 or 3.6:** This needs to be installed as shown. The microSD card slot (on the left above) goes to the left when installed.

**74HCT245 Octal Bus Transceiver:** This needs to be installed as shown. The direction indicator goes to the left when installed.

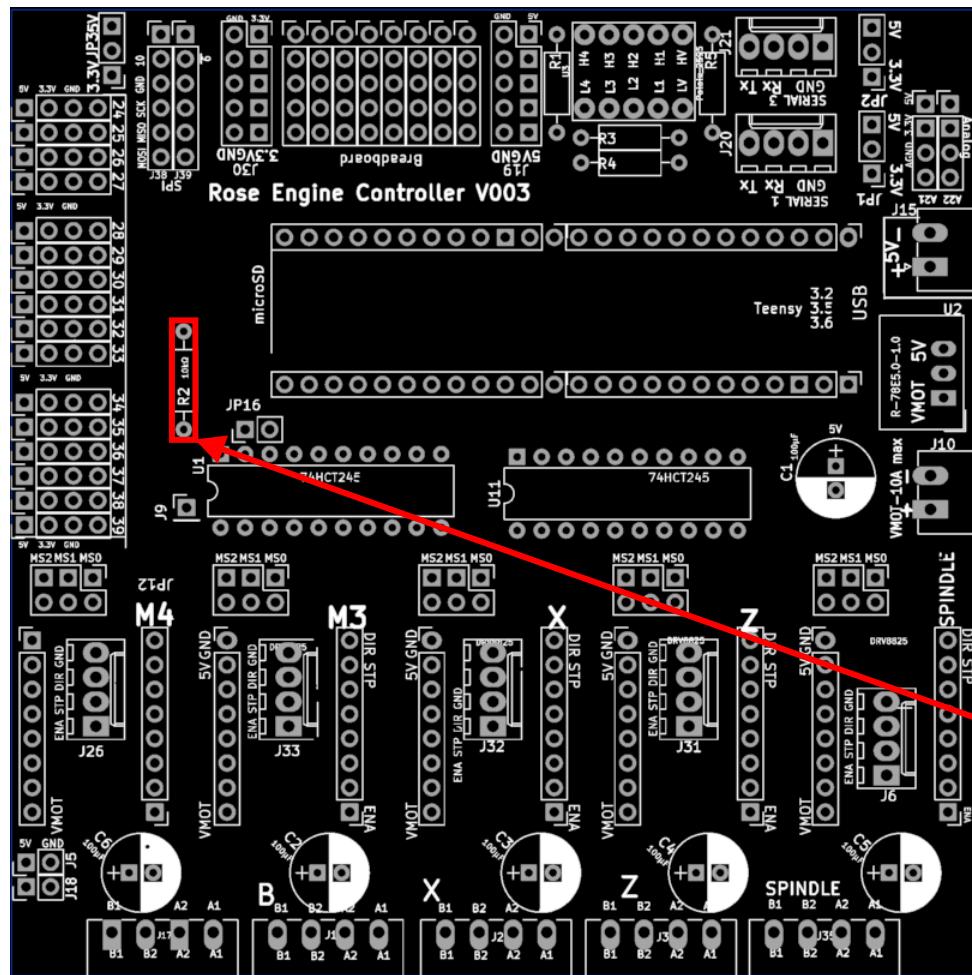
# MDF Rose Engine Lathe 2.0

## Build Instructions – Control System for Multiple Stepper Motors

### Printed Circuit Board version 003

#### Through-Hole Components, part 1

Solder in the resistors as noted below.



**NOTE:** the direction in which these are installed is not critical, but when I solder more than one into place, I try to solder them the same for each side. Makes it look more dress-right-dress. (My SGT would be happy.)

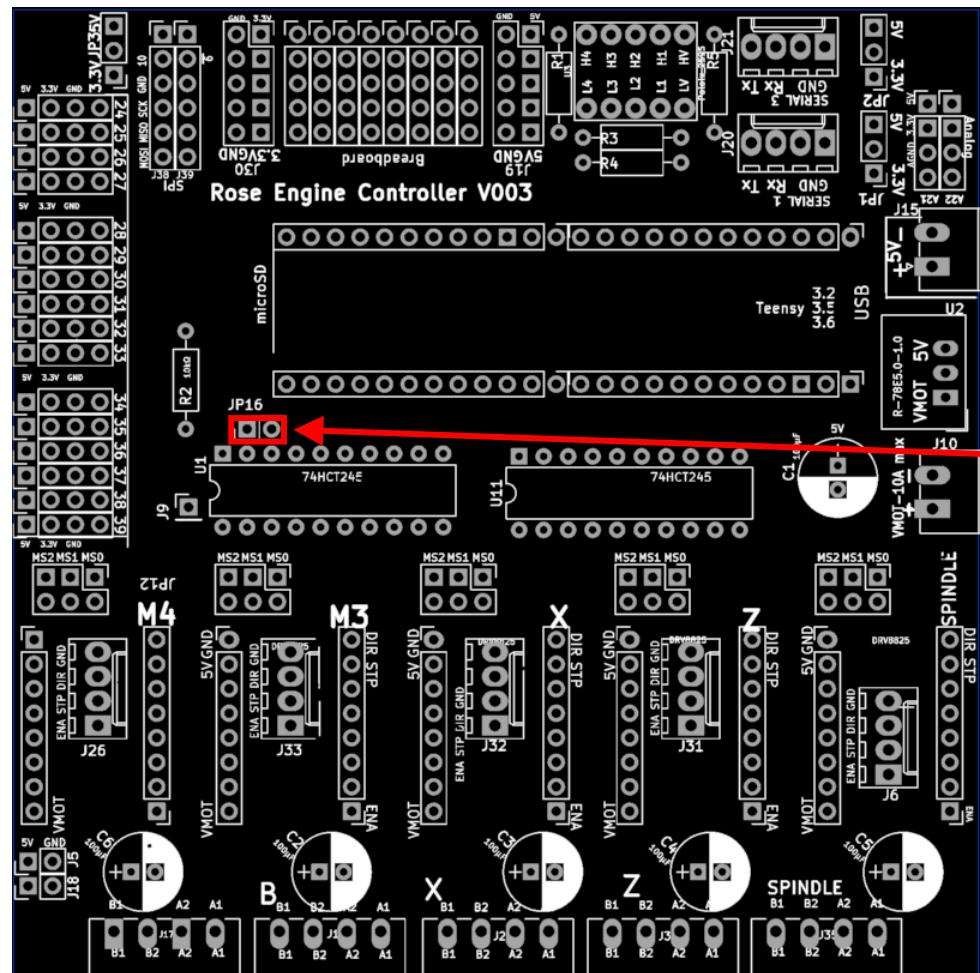


# MDF Rose Engine Lathe 2.0

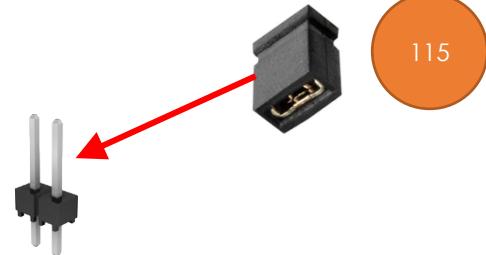
## Build Instructions – Control System for Multiple Stepper Motors

If you are using the version 002i PCB, follow these instructions; otherwise, continue to the next page.

Solder in a header for bypassing the resistor. Add a mini-jumper.



Mini Jumper – Installed across pins in header connector #114.



Header Connector,  
vertical, 2 pins (1x2),  
2.54mm pin spacing

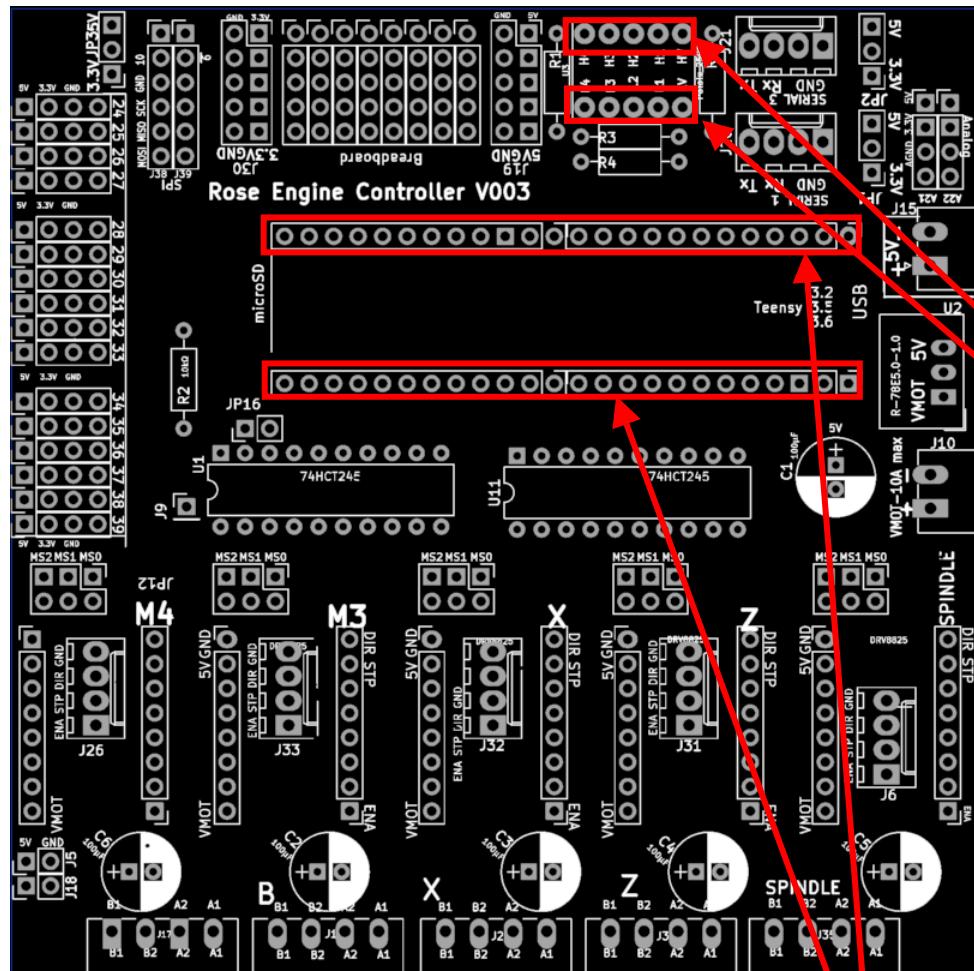
114

# MDF Rose Engine Lathe 2.0

## Build Instructions – Control System for Multiple Stepper Motors

### Headers for Integrated Circuits

Solder in the 2 headers for the Pololu 2595 and 2 headers for the Teensy.



**NOTE 1 :** The headers must be at 90° to the circuit board. It is necessary to ensure that they remain perpendicular or the chip's pins will not fit into the header pin holes.

I have used a piece of  $\frac{3}{4}$ " MDF (2" x 3") and taped the header to the edge. Then the MDF can be taped to the PCB, holding it vertically whilst the PCB is flipped over to solder the header into place.

Headers (2) for  
Pololu Logic  
Level Shifter



**NOTE 2 :** Recommend you start with the header at the edge of the board, and work down from there (down being as shown in the picture to the left). This gives you room to tape the MDF block to the PCB as you go.

Headers (2) for  
Teensy 3.5

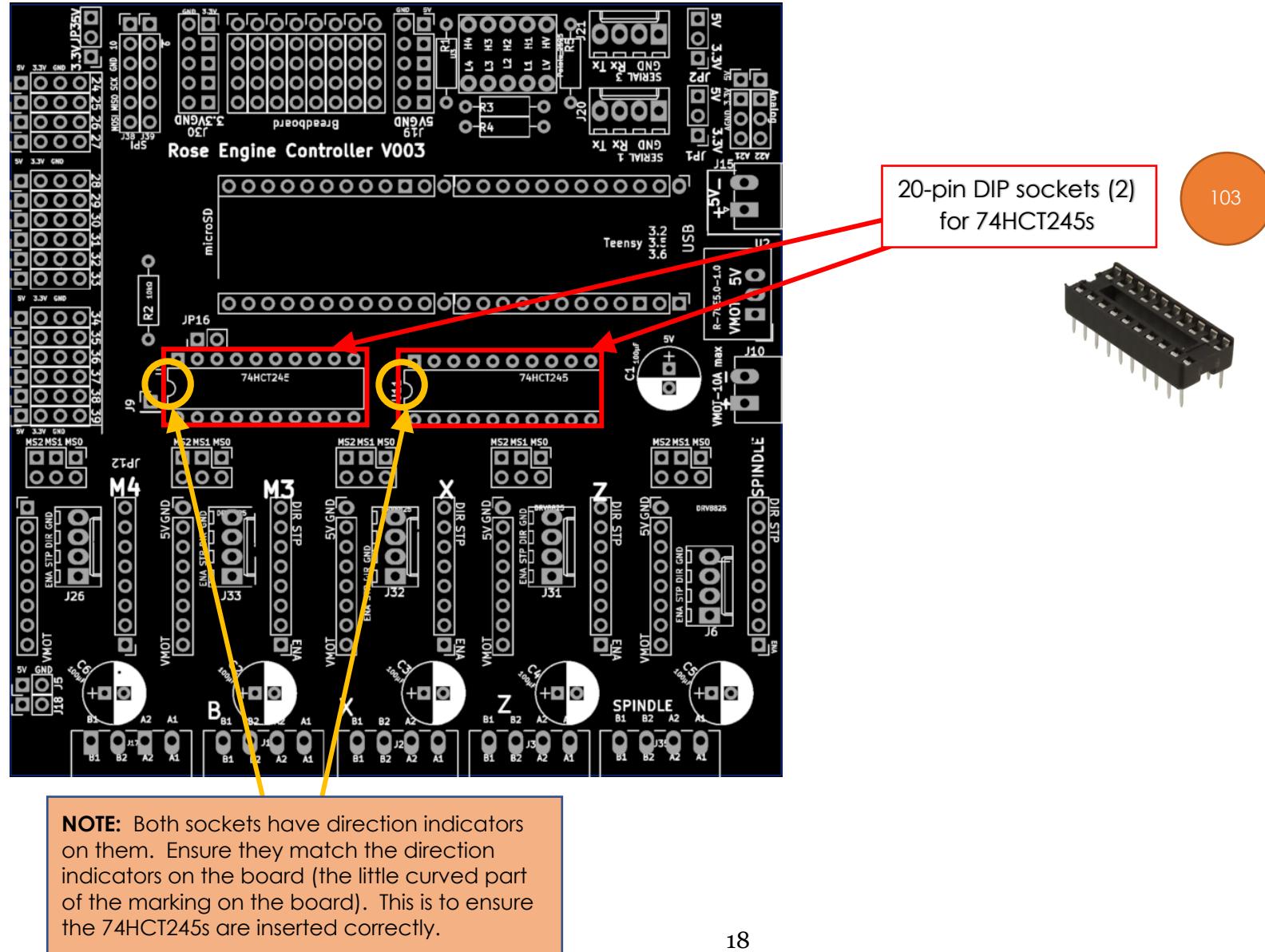


# MDF Rose Engine Lathe 2.0

## Build Instructions – Control System for Multiple Stepper Motors

### Headers for Integrated Circuits

Solder in the 2 DIP sockets for the 74HCT245s.

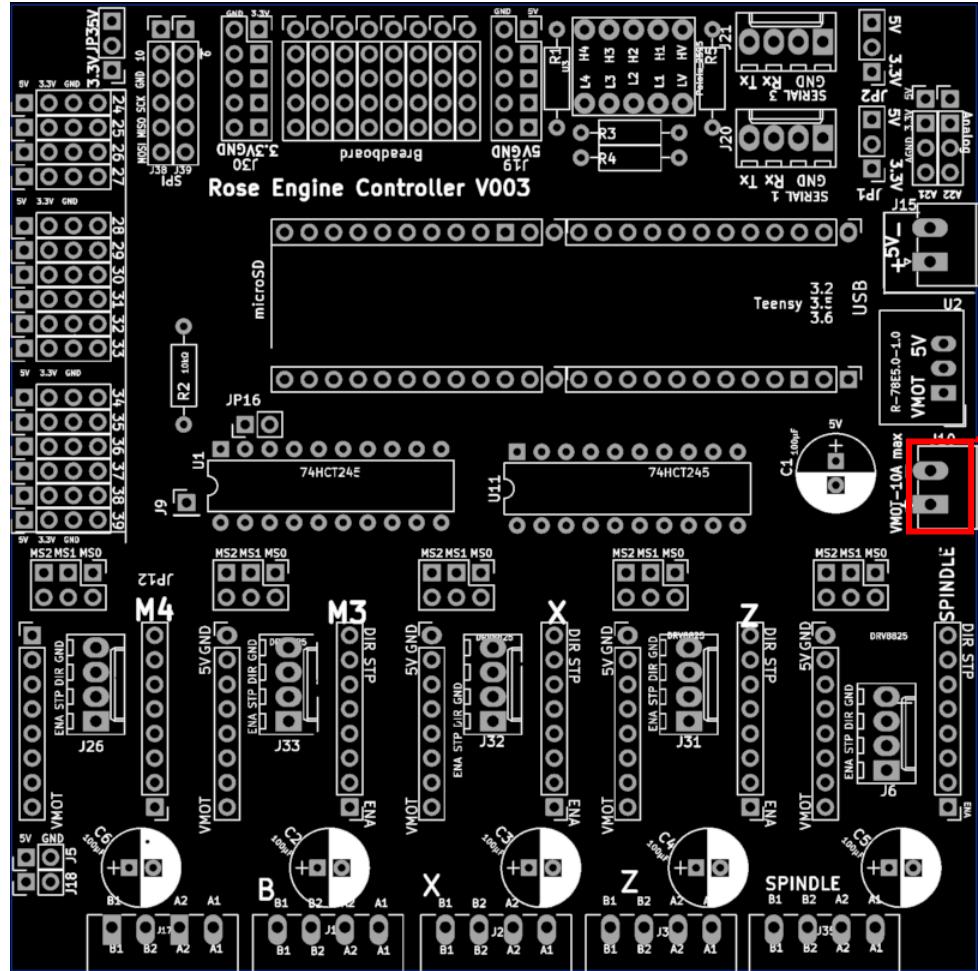


# MDF Rose Engine Lathe 2.0

## Build Instructions – Control System for Multiple Stepper Motors

### Power Header Connector

Solder in the power connector as noted below.



**NOTE:** Be sure the openings are facing out from the PCB. The plug for the power will overhang the PCB.

Header Connector,  
90 degree, 2 pins,  
3.50mm pin spacing



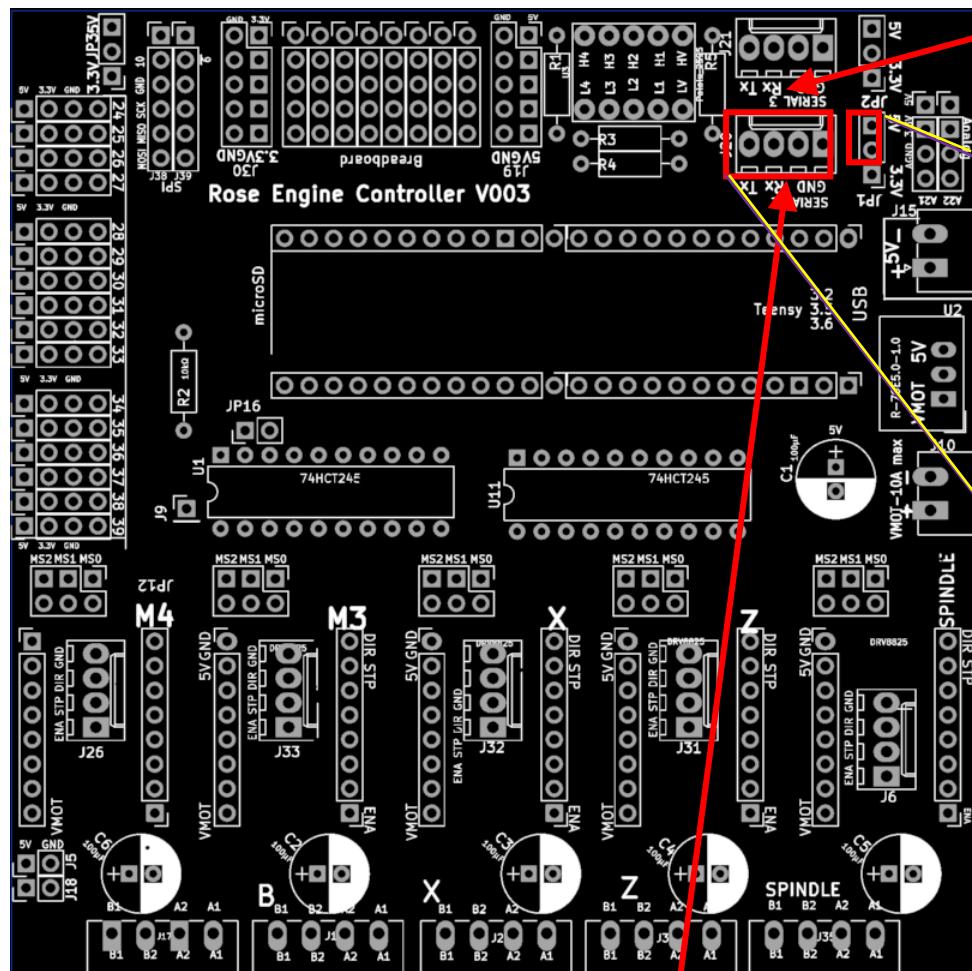
112

# MDF Rose Engine Lathe 2.0

# Build Instructions – Control System for Multiple Stepper Motors

# Nextion Display Header Connectors

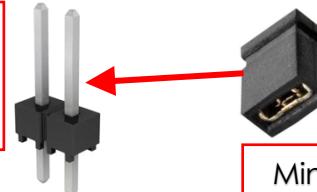
Solder in the power and signal connector for Serial 1 as noted below.



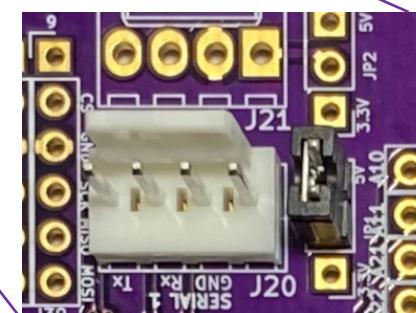
Header Connector,  
vertical, 4 pins,  
2.54mm pin spacing



Header Connector,  
vertical, 2 pins,  
2.54mm pin spacing

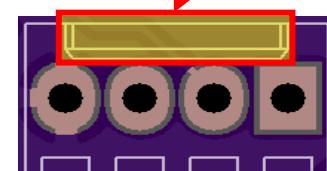


Mini Jumper –  
Installed across  
pins in header  
connector  
#114.



## **As Installed**

**NOTE 1:** The plastic tab projecting up from the connector should be aligned with this marking on the PCB.

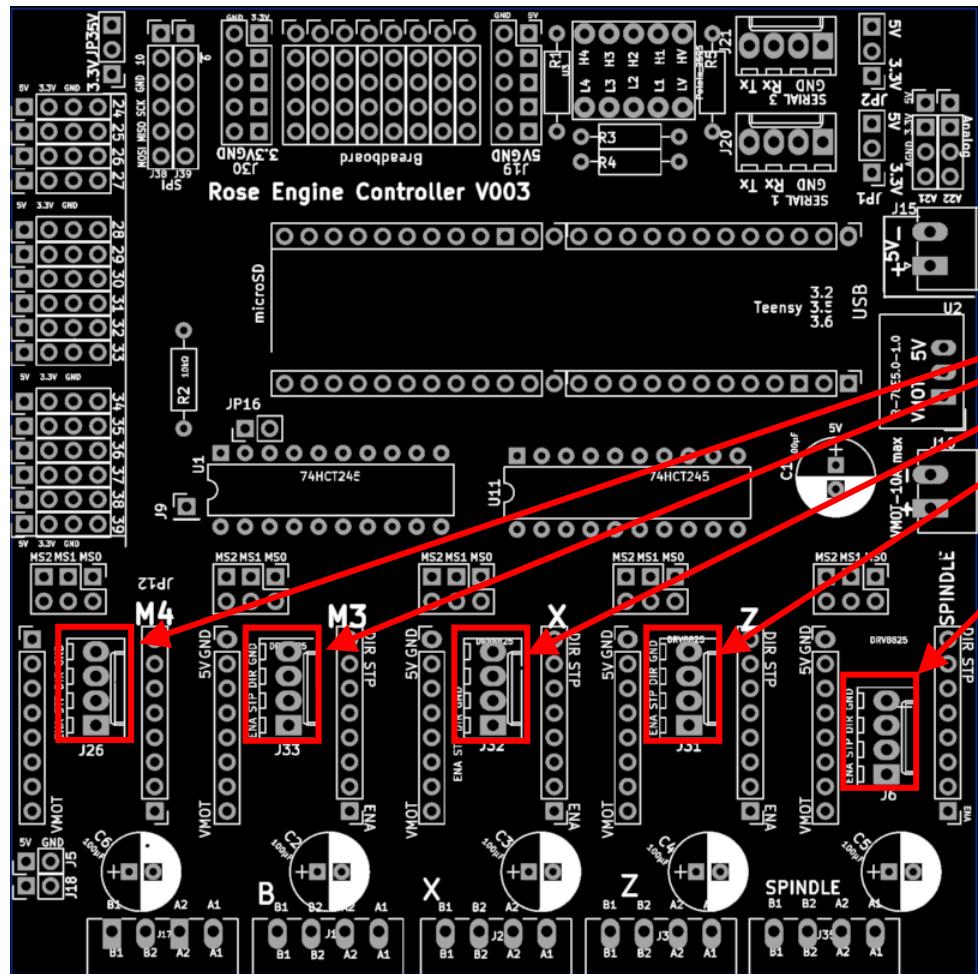


# MDF Rose Engine Lathe 2.0

## Build Instructions – Control System for Multiple Stepper Motors

### Stepper Motor Driver Header Connectors

Solder in the stepper motor driver connectors as noted below.

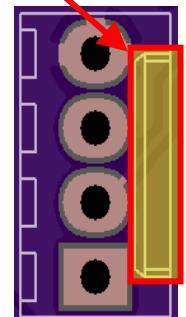


Header Connector,  
vertical, 4 pins,  
2.54mm pin spacing



111

**NOTE:** The plastic tab projecting up from the connector should be aligned with this marking on the PCB.

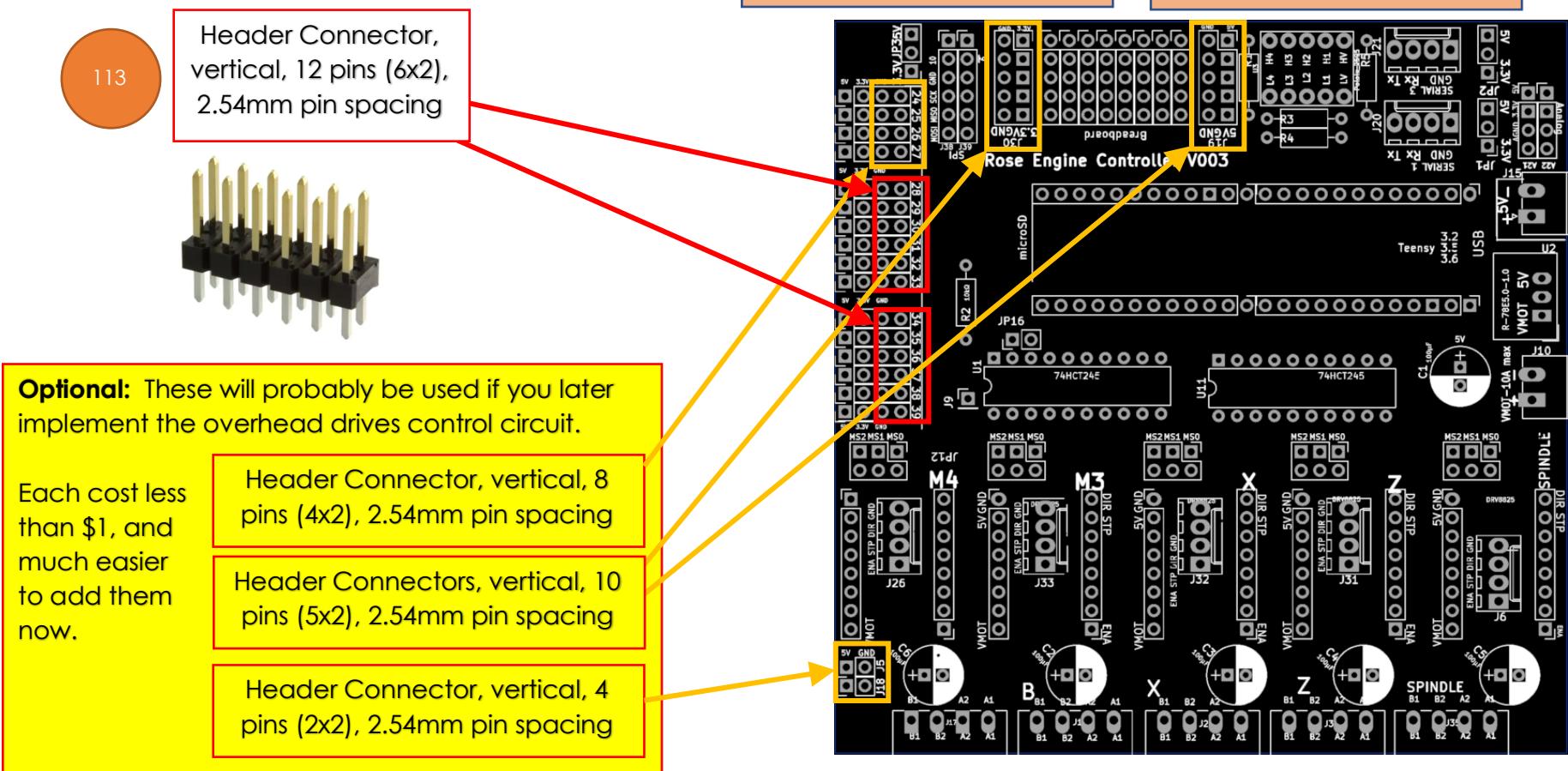


# MDF Rose Engine Lathe 2.0

## Build Instructions – Control System for Multiple Stepper Motors

### Limit Switch Header Connectors

Solder in the limit switch connector pins as noted below.



Amphenol ICC part number to use

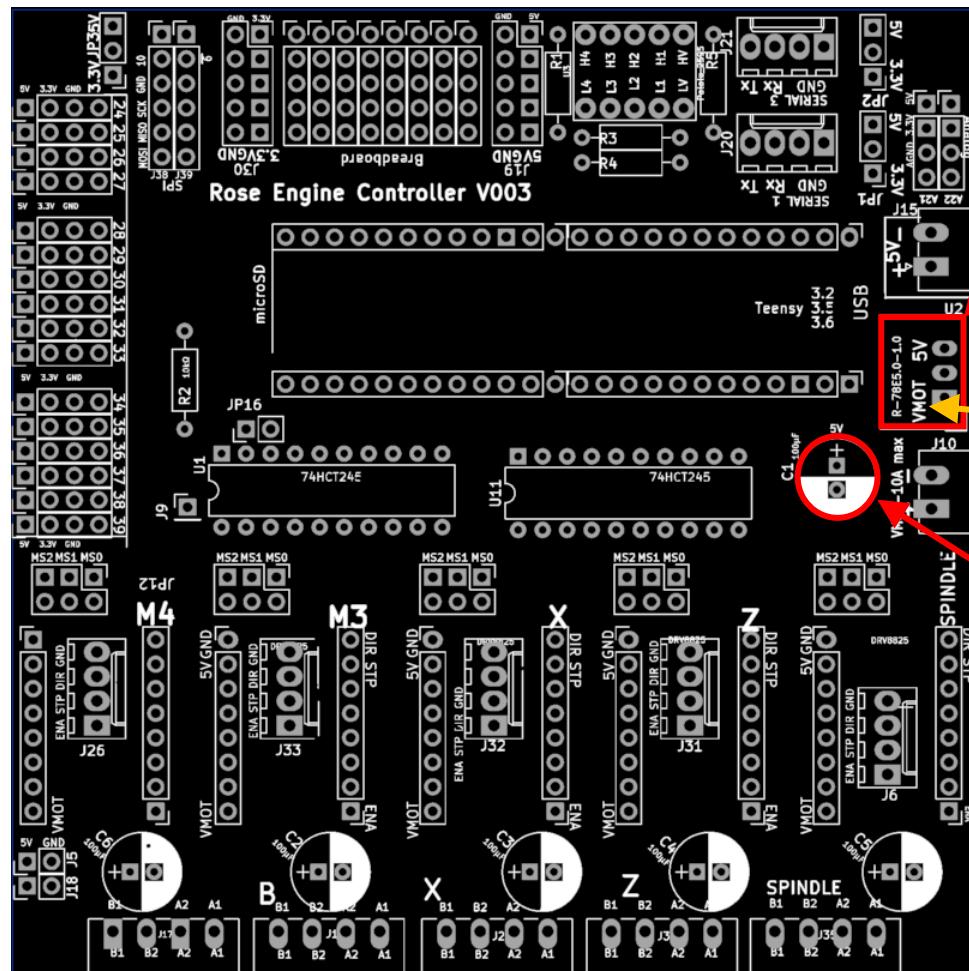
Pins	Amphenol P/N
24 – 27	77313-101-08LF
28 – 33	77313-101-12LF
34 – 39	77313-101-12LF
J5/J18	77313-101-04LF
J19/J30	77313-101-10LF

# MDF Rose Engine Lathe 2.0

## Build Instructions – Control System for Multiple Stepper Motors

### Through-Hole Components, part 2

Solder in the components noted below.



R-78E5.0-1.0 DC  
DC Converter

107

NOTE 1: The DC converter  
should fit over the box  
printed for it on the board.

NOTE 2: This dot indicates the  
side which should be over the  
pin labeled VMOT.

100 µF Capacitor

105

White stripe on the negative (-)  
side (generally).

NOTE 3: Be sure the capacitor is installed  
correctly. The negative (-) side goes in  
the area shaded white.

Longer lead on the positive (+) side.

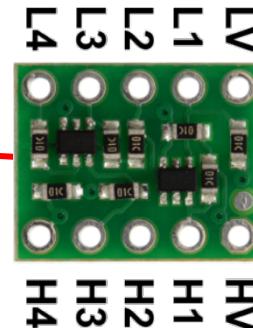
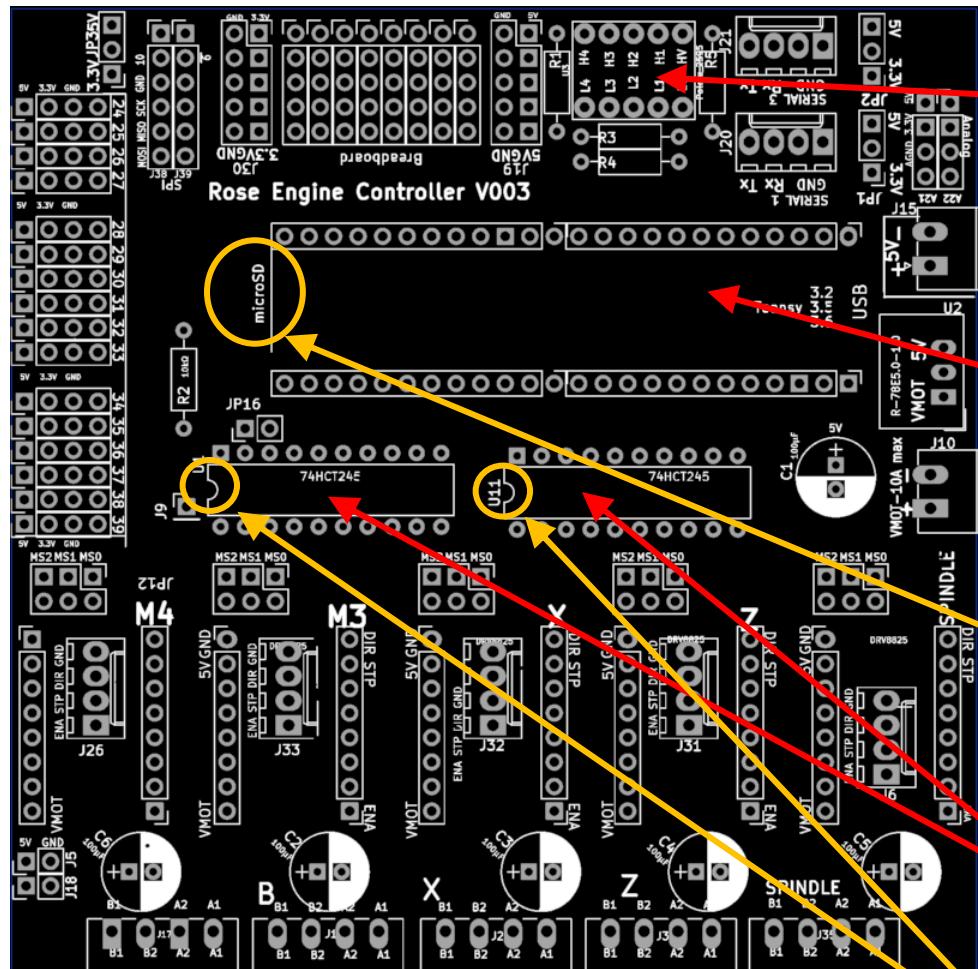
**KEY NOTE:** Great care must be taken when soldering these components into place. Be sure to not overheat them.

# MDF Rose Engine Lathe 2.0

## Build Instructions – Control System for Multiple Stepper Motors

### Install Components

Install the components as noted below.



**Pololu 2595:** This picture is the bottom of the Pololu 2595. It needs to be installed so that the labels on the Pololu 2595 match the PCB.



**Teensy 3.5 or 3.6:** This needs to be installed as shown. The microSD card slot (on the left above) goes to the left when installed.



**74HCT245 Octal Bus Transceiver:** This needs to be installed as shown. The direction indicator goes to the left when installed.

# MDF Rose Engine Lathe 2.0

## Build Instructions – Control System for Multiple Stepper Motors

### Section 2 – Power Cables

#### Wiring – Power Supply (LRS-100-24)

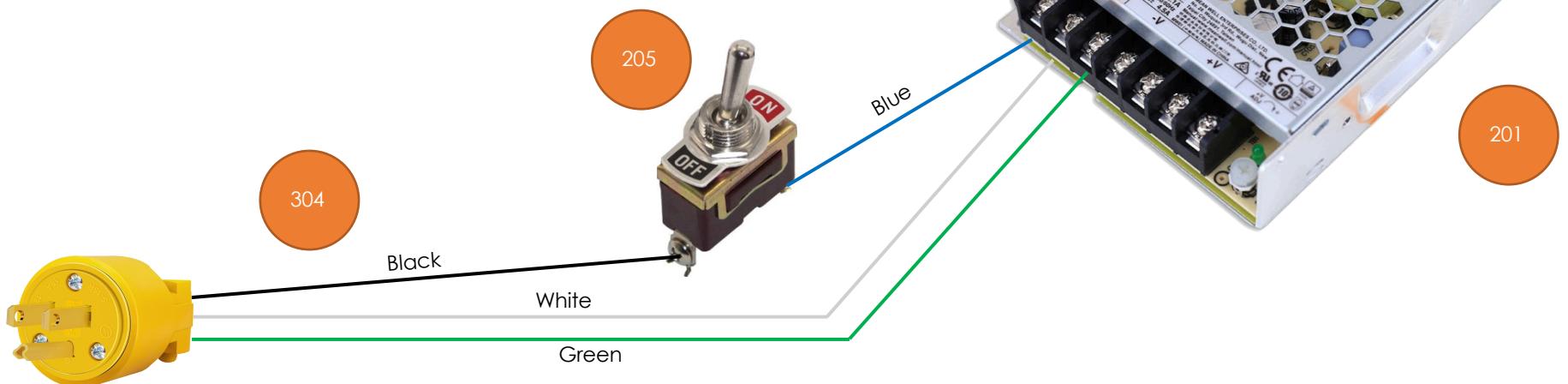
##### *Power Infeed*

The power infeed is connected as:

Wire Color	Power Switch
Black Incoming Power	Terminal 1
Blue Switched Power	Terminal 2

Conductor Type	Stranded copper
Conductor Size	16 AWG (min)
Cable Size	3 conductors / cable

Wire Color	LRS-100-24
Black from Power Switch Terminal 2	L
White	N
Green	GND ( $\frac{1}{-}$ )

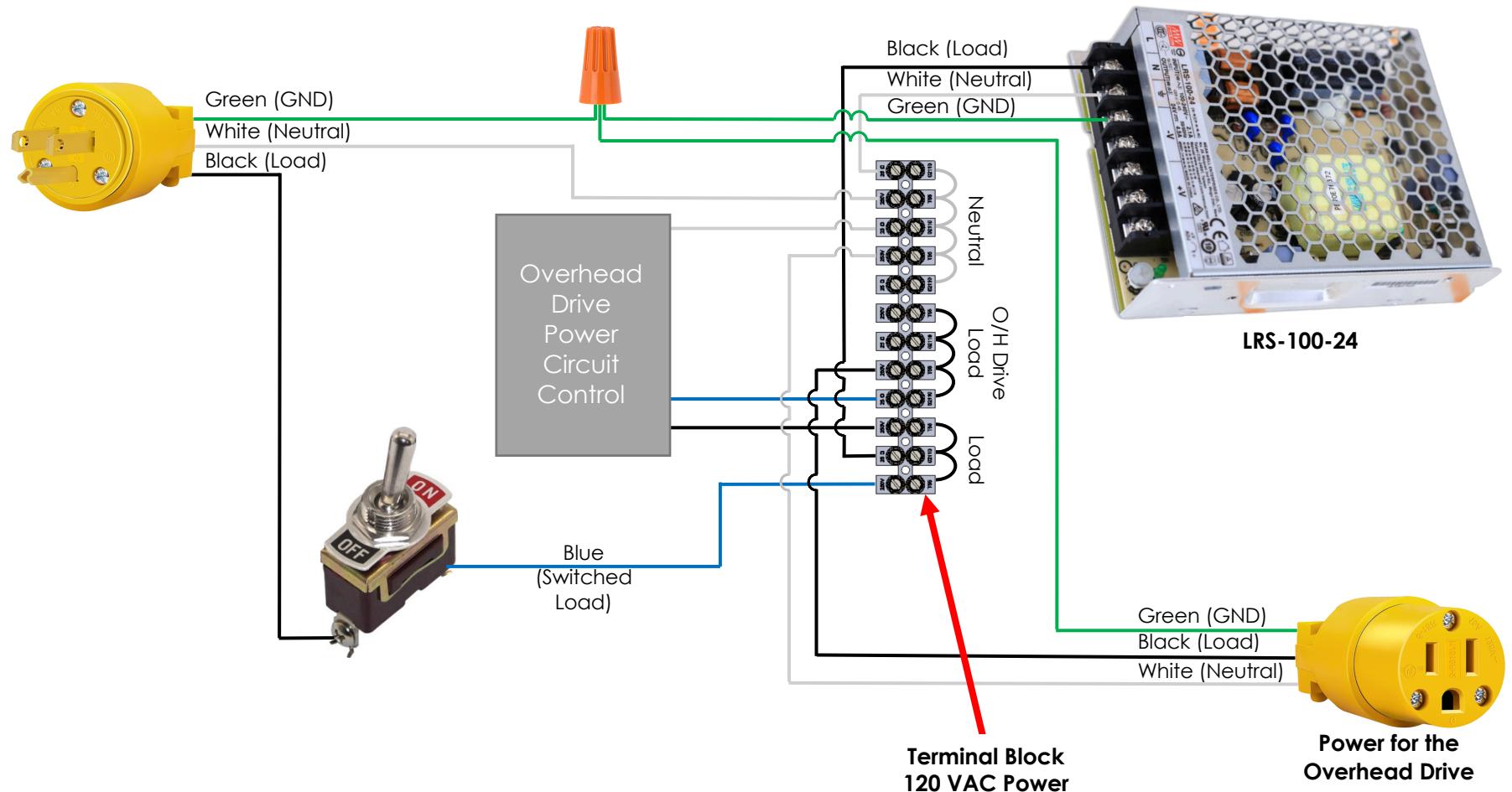


# MDF Rose Engine Lathe 2.0

## Build Instructions – Control System for Multiple Stepper Motors

### *When Planning to Implement the Overhead Drives Control*

The power infeed is connected as shown in the scenario below. The additional positions provided by the terminal block are needed for the Overhead Drives Control circuits.



# MDF Rose Engine Lathe 2.0

## Build Instructions – Control System for Multiple Stepper Motors

### Power Outfeed

terminal block is used to make the installation and maintenance of the system's components easier. Using a terminal block allows connections to be added, changed, or removed without the risk of any other connections loosening.

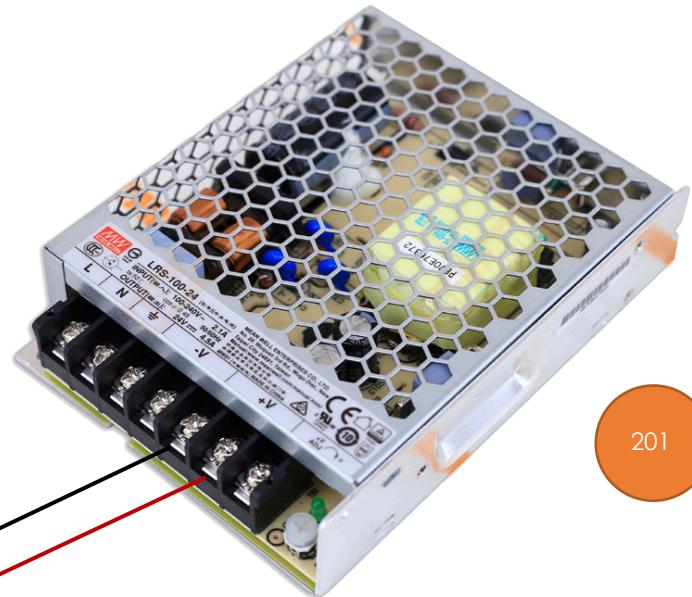
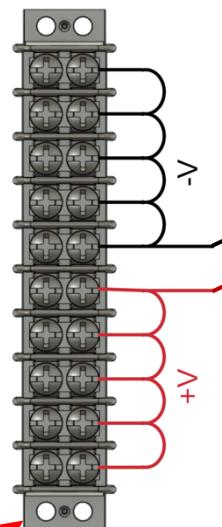
Conductor Type	Stranded or solid copper
Conductor Size	20 or 22 AWG
Cable Size	2 conductors / cable

304

One of the power supply's +V outfeeds, and one of the -V outfeeds is connected up to the terminal block where the power will be distributed.

- V is connected to the other side of the terminal block using a white or black wire. That same colour wire is then used to cascade the -V side of the power to the next 4 terminals.
- +V is connected to one side of the terminal block using a red wire, and then that same colour wire is used to then cascade the +V side of the power to the next 4 terminals.

Terminal Block  
24 VDC Power



204

201

# MDF Rose Engine Lathe 2.0

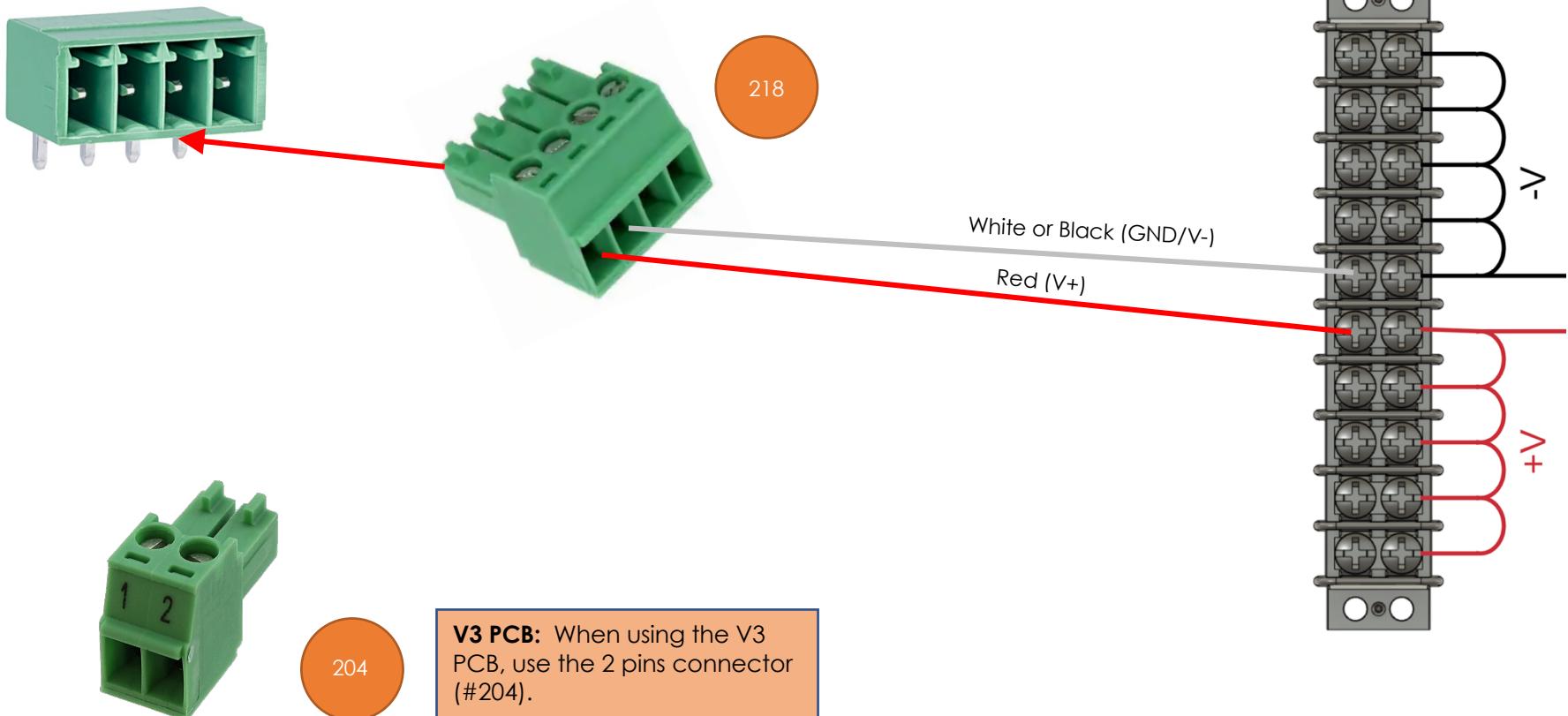
## Build Instructions – Control System for Multiple Stepper Motors

### Power Cable – 24V Power Supply to PCB

Screw the power cable wires into the terminal block plug as noted below.  
Ensure the wire is long enough to reach the PCB when installed.

This is plugged into the power header connector (#112) installed on the PCB (above).

Terminal Block	Wire Color	PCB
+V terminal	Red	○ +24V
-V terminal	White	○ -24V



# MDF Rose Engine Lathe 2.0

## Build Instructions – Control System for Multiple Stepper Motors

### Power Wiring – DM542T Stepper Motor Drivers (4)

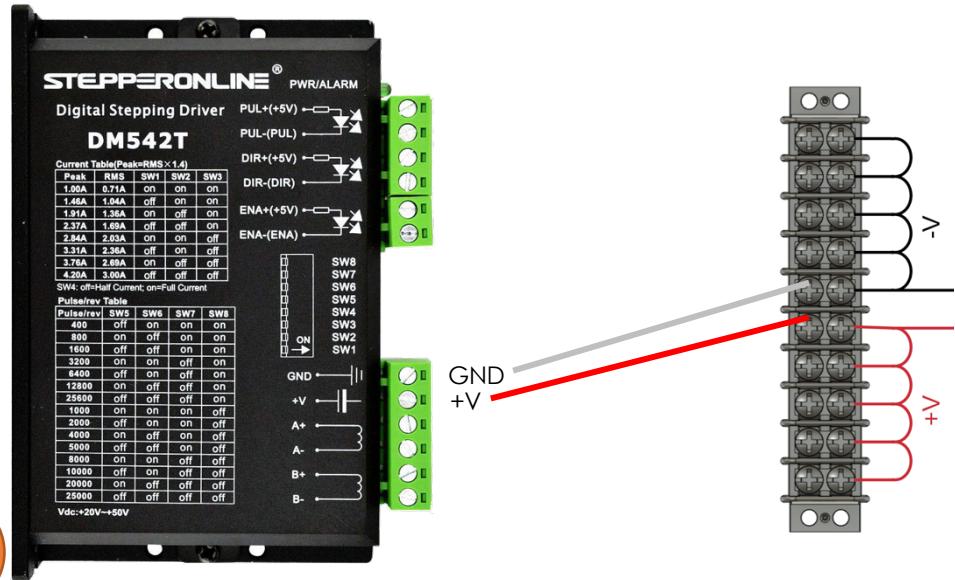
Each of the 4 DM542T stepper motor drivers is connected to the terminal block for power.

Terminal Block	Wire Color	DM542T
+V terminal	Red	+V
-V terminal	White	GND $\frac{1}{2}$

Conductor Type	Stranded or solid copper
Conductor Size	20 or 22 AWG
Cable Size	2 conductors / cable

303

202



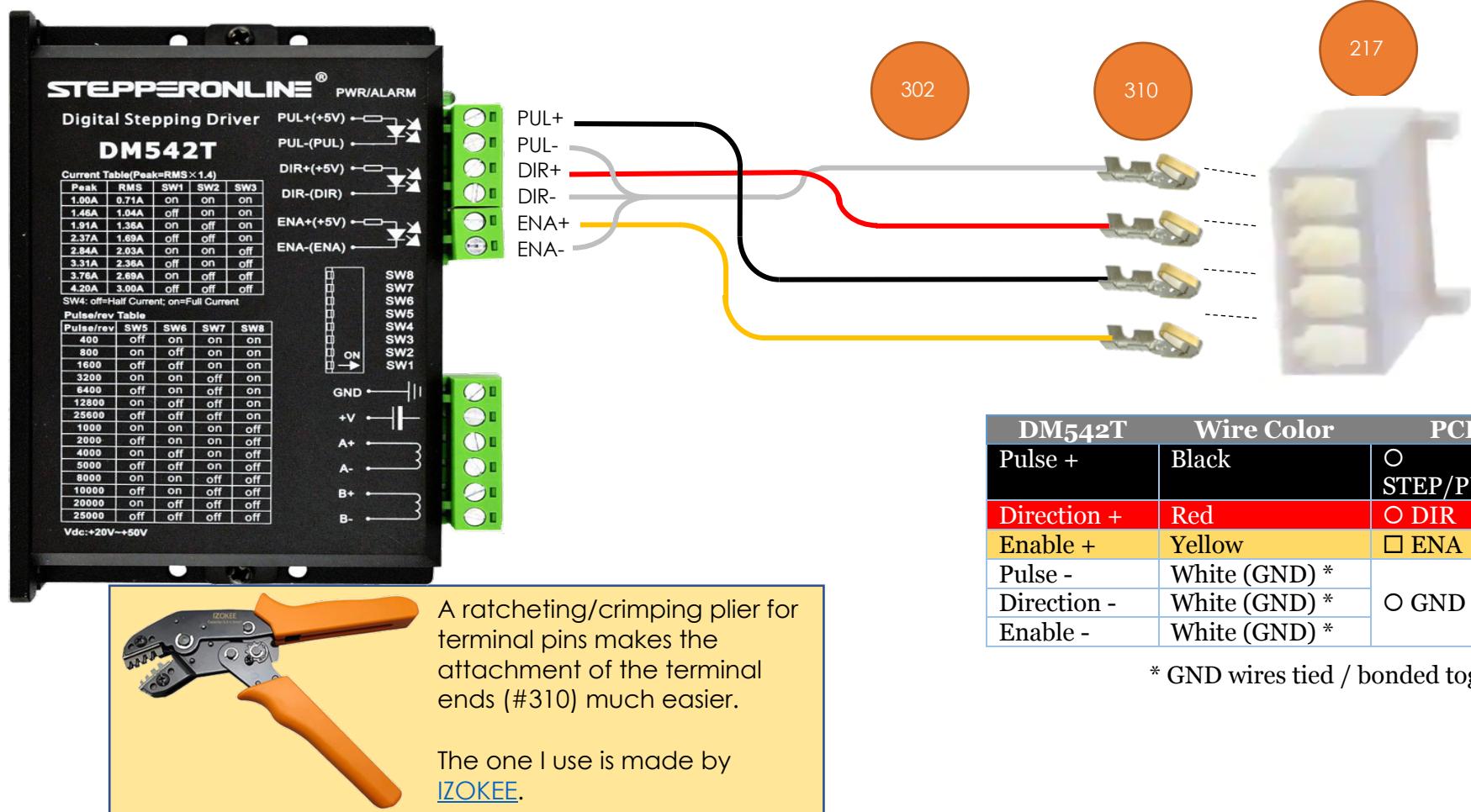
# MDF Rose Engine Lathe 2.0

## Build Instructions – Control System for Multiple Stepper Motors

### Section 3 – Stepper Motor Driver Signal Cables

#### Signal Cables – PCB to DM542T Stepper Motor Drivers

Install the pre-crimped ends of the wires into the housing. The other end is connected to the stepper driver as shown below. There are 4 of these.



# MDF Rose Engine Lathe 2.0

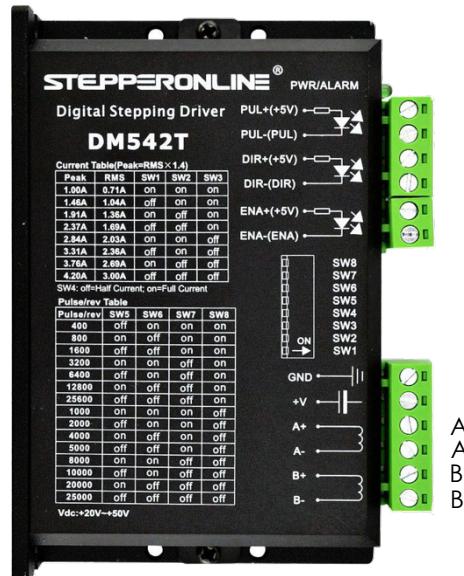
## Build Instructions – Control System for Multiple Stepper Motors

### Signal Wiring –Stepper Motor Drivers to GX-16/4 Jacks (4)

Each of the 4 stepper motors is connected to the stepper motor drivers via GX-16/4 Jacks.

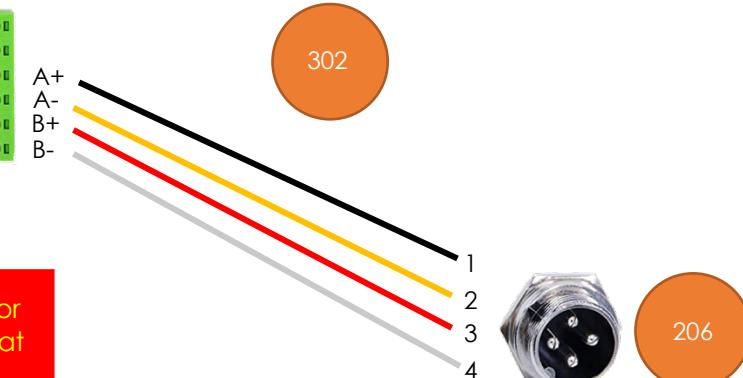
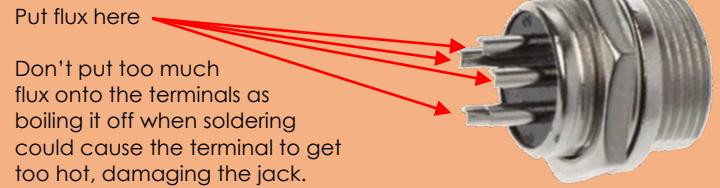
DM542T	Wire Color	GX-16/4 Pin
A+	Black	1
A-	Yellow	2
B+	Red	3
B-	White	4

Conductor Type	Stranded copper
Conductor Size	20 AWG
Cable Size	4 conductors / cable
Cable Length	6 to 8"

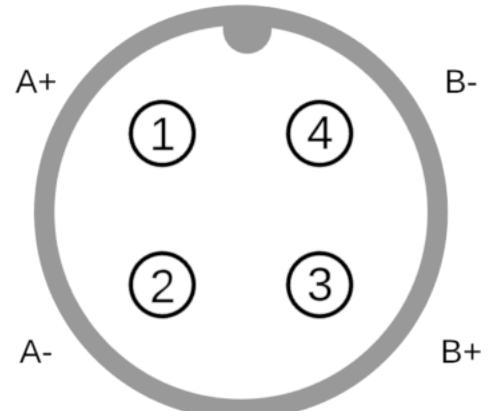


**KEY POINT:** It is best to solder the FX-16/4 jacks to the cables and attach the jacks to the metal plate before attaching the other end to the DM542T stepper motor driver. This is a lot easier.

**NOTE:** When soldering wires to the GX-16 jack, it is a good practice to put a small dab of soldering flux onto the terminal before beginning the soldering. This will help it happen faster, minimizing the chance for damage to the jack.



**TROUBLESHOOTING:** If the motor is running backwards (from what you wish), swap the black and yellow wires (A+ and A-). This can be done easiest at the DM542T rather than resoldering the jack.



# MDF Rose Engine Lathe 2.0

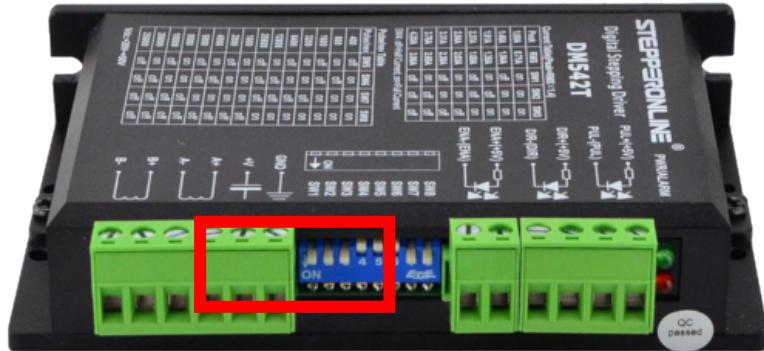
## Build Instructions – Control System for Multiple Stepper Motors

### Switch Settings

Set the switches on the DM542Ts as:

Purpose	Set to	Switch	Setting
Current	2.8A Peak 2.03A RMS	1	ON
		2	ON
		3	OFF
Pulses / Rev	6400	4	OFF
		5	OFF
		6	ON
		7	OFF
		8	ON

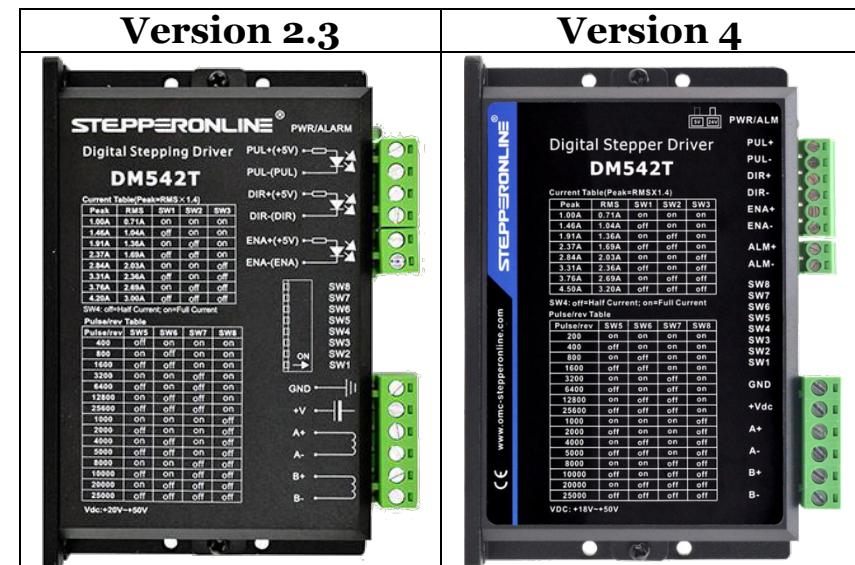
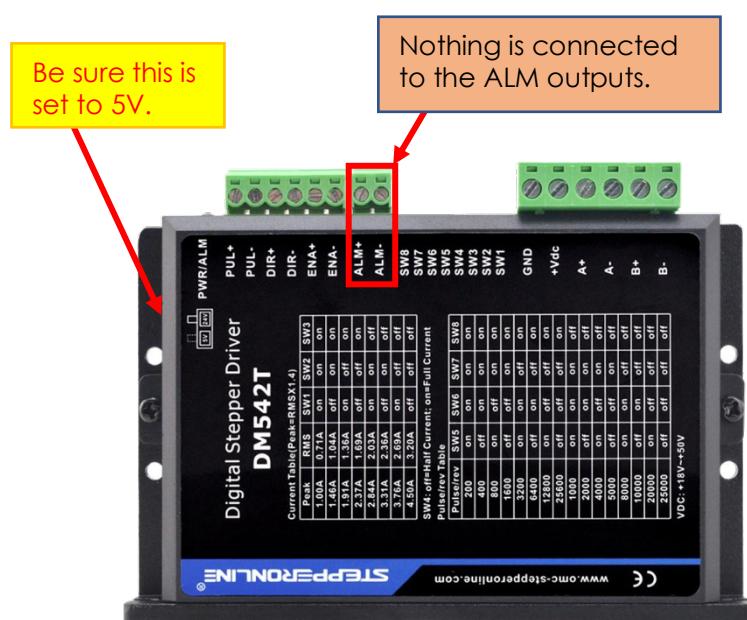
The current could be set higher with this driver; however, the selected NEMA 23 stepper motor does not need that, so it is set thusly.



**NOTE:** switch settings in the picture are not correct – this is a stock photo from the Internet. Use the settings in the table to the left.

### DM542T Version 4

There is a newer version (v4) of the StepperOnline DM542T. For this version, the voltage must be set to 5V, and the ALM outputs can be ignored.



# MDF Rose Engine Lathe 2.0

## Build Instructions – Control System for Multiple Stepper Motors

### Section 4 – Nextion Display Signal Cable

#### Why use a Different Jack Type for the Nextion Display?

It is a really good idea to have a different connector for the stepper motors than the Nextion touch screen display.

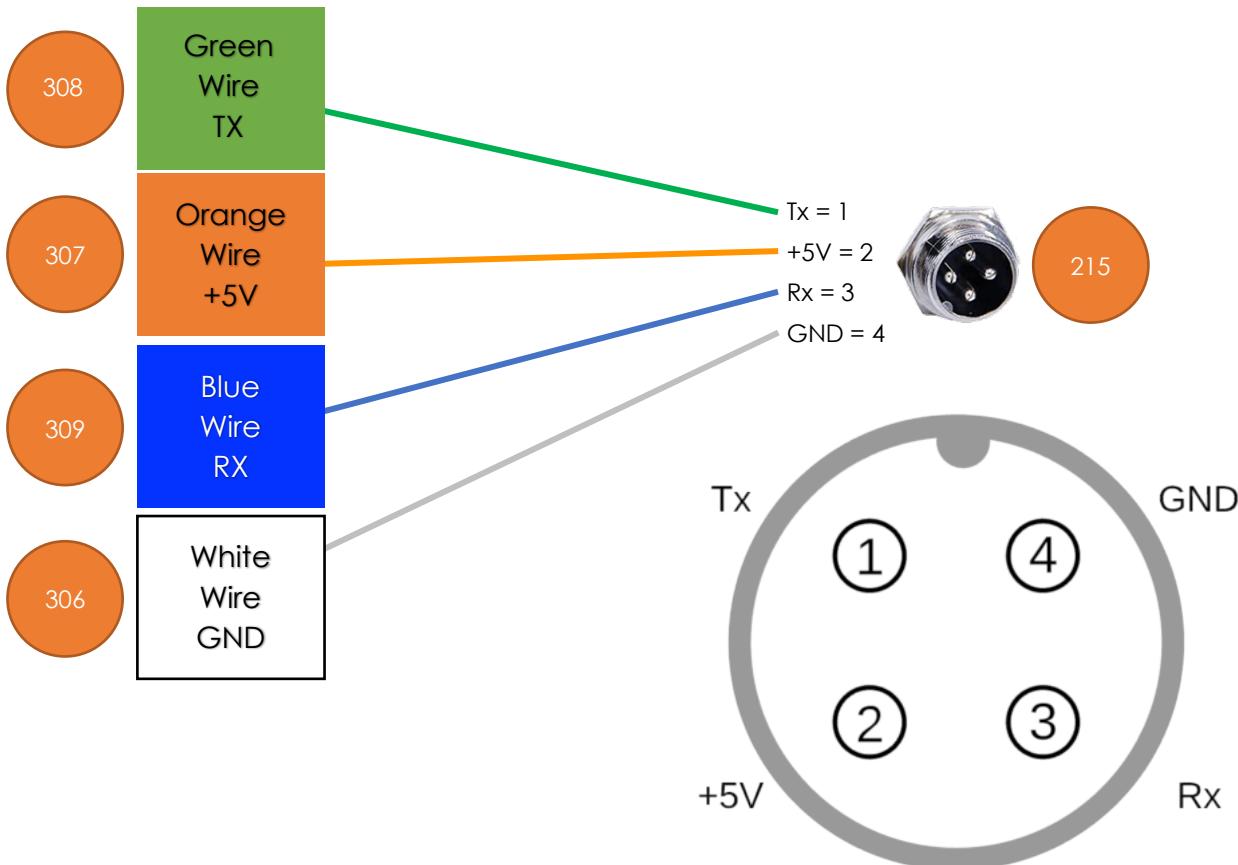
	Nextion Touch Screen Display	Stepper Motors
Cable Use	<ul style="list-style-type: none"><li>Serial communications</li><li>Power to the display</li></ul>	<ul style="list-style-type: none"><li>Motor stepping, but at a higher voltage</li></ul>
Risk if Hooked Up Wrongly	<ul style="list-style-type: none"><li>The higher voltages will probably cause the display to fail.</li></ul>	<ul style="list-style-type: none"><li>The motors will certainly work</li><li>May damage the motor.</li></ul>
Recommended Connector	<ul style="list-style-type: none"><li>GX-12/4<ul style="list-style-type: none"><li>Being 12mm in diameter makes the plug not able to connect to the GX-16/4 jack.</li></ul></li></ul>	<ul style="list-style-type: none"><li>GX-16/4<ul style="list-style-type: none"><li>Being 16mm in diameter makes the plug not able to connect to the GX-12/4 jack.</li></ul></li></ul>
Optional Connectors	<ul style="list-style-type: none"><li>Could use a GX-16 with more than 4 connectors (e.g., GX-16/5). The additional pins will just be unused, but this would prevent plugging the plug into the wrong jack.</li><li>RJ-45</li></ul>	<ul style="list-style-type: none"><li>n/a</li></ul>

# MDF Rose Engine Lathe 2.0

## Build Instructions – Control System for Multiple Stepper Motors

### Signal Cable – PCB to Nextion Display

The Nextion touch screen is connected to the PCB via GX-12/4 connector.



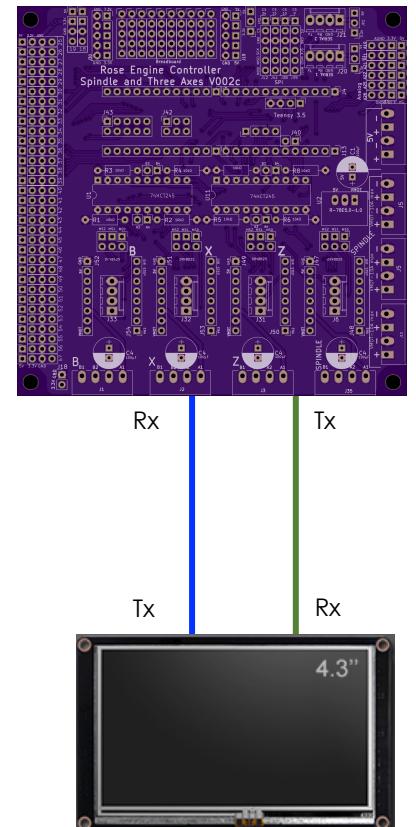
#### NOTE:

- Tx on the PCB is connected to Rx on the Nextion HMI display.
- Rx on the PCB is connected to Tx on the Nextion HMI display

**KEY POINT:** It is best to

1. Solder the jack to the cables
2. Install the jack into the 2-gang plate.
3. Once that is in place, then insert the pre-crimped ends into the housing.

This is a lot easier.

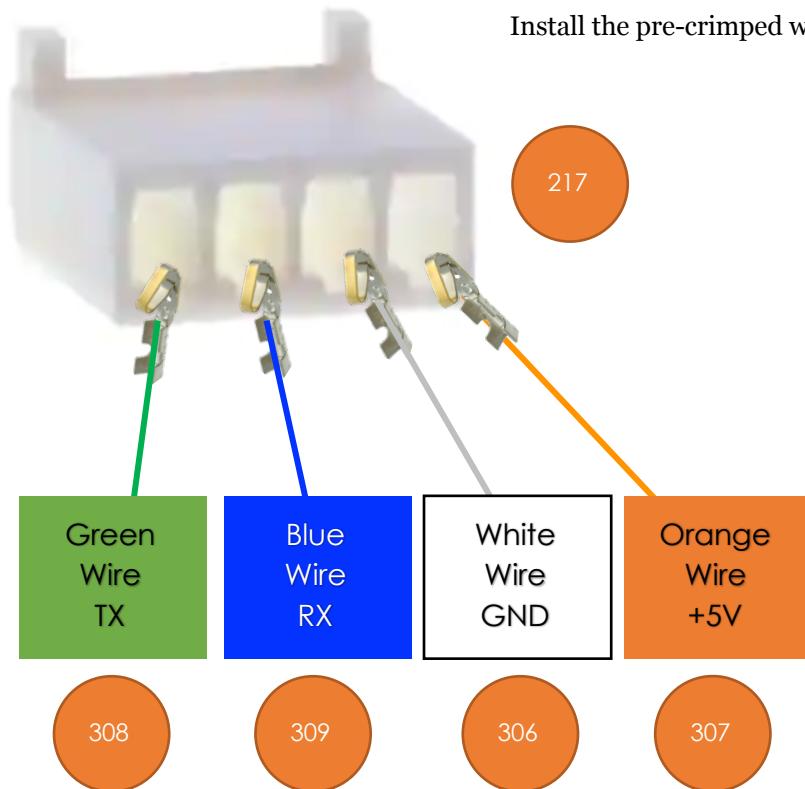


Nextion HMI Display

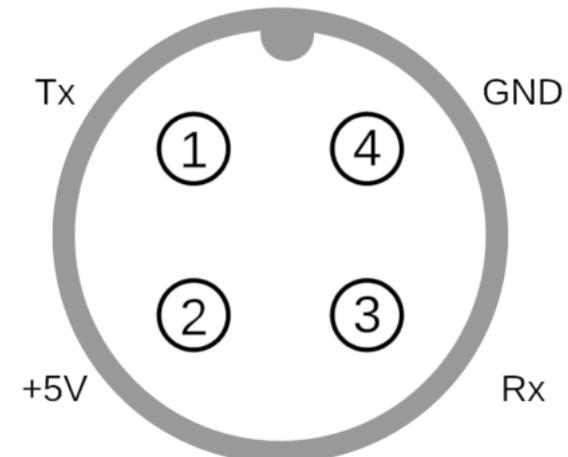
# MDF Rose Engine Lathe 2.0

## Build Instructions – Control System for Multiple Stepper Motors

### Signal Cable – PCB to Nextion Display



Install the pre-crimped wires into the housing. There are 4 of these.



**NOTE:** It is a very good practice to perform a continuity test to ensure the pins are wired correctly (i.e., pin 1 in the GX-12 jack should be connected to the left wire as shown in the picture to the right).

# MDF Rose Engine Lathe 2.0

## Build Instructions – Control System for Multiple Stepper Motors

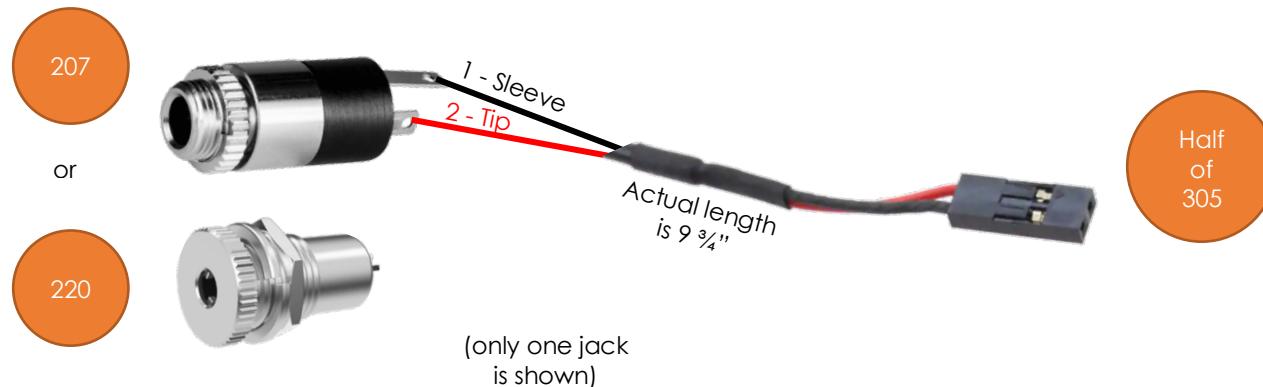
### Section 5 – Limit Switch Signal Cables

#### **Signal Wiring – PCB to 3.5mm Audio Jacks for Limit & Home Switches**

The limit switches are connected to the PCB via a 3.5mm (1/8") audio female jack. 6 pins on the Teensy are used (one for each limit switch). These can be any of the pins between 25 and 39.

The cable used is half of part #305. On the V3 Boards, you will not be able to get two connectors per cable. Longer length is needed.

PCB	Wire Color	Audio Jack
O pin #	Red	Tip / pin 2
O GND	Black (or White)	Sleeve / pin 1



#### **NOTES:**

1. Most audio jacks that are available are stereo with 3 connectors. Only 2 are needed, so the 3<sup>rd</sup> one will go unused.
2. Experience has shown that it is a good practice to ensure a mono plug will work correctly for the way you have soldered the connections.

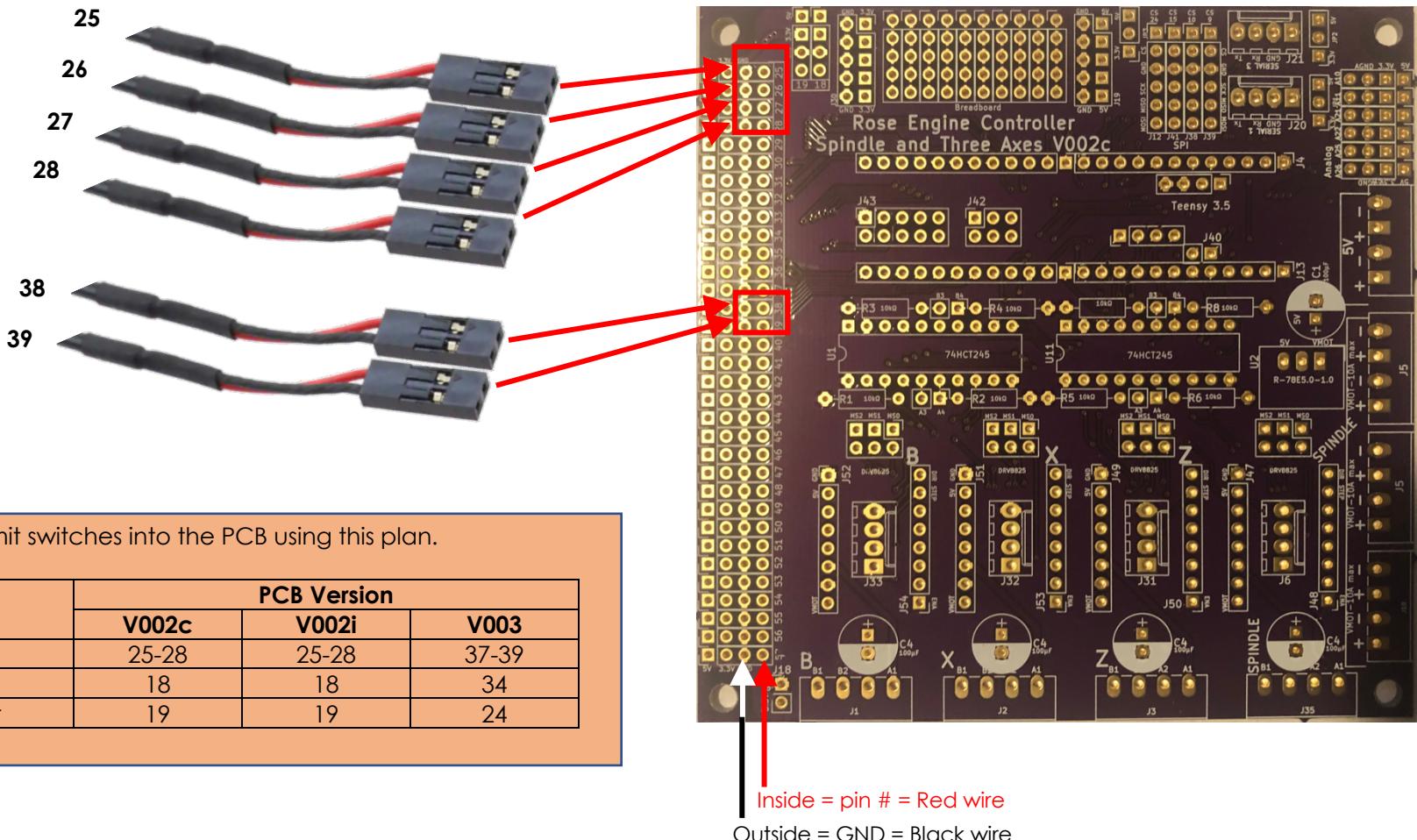
**KEY POINT 1:** The sleeve must be connected to ground (GND). Typically, this is pin 1, but check based on the jack you are using.

**KEY POINT 2:** It is a really good idea to label each cable with the pin it is used for.

# MDF Rose Engine Lathe 2.0

## Build Instructions – Control System for Multiple Stepper Motors

Connect the cables to the header pins. The recommended pins are noted below, but any between 25 and 39 can be used.



# MDF Rose Engine Lathe 2.0

## Build Instructions – Control System for Multiple Stepper Motors

### Section 6 – Final PCB Steps

#### Mounting the PCB to the MDF Board

The Teensy microcontroller is installed onto the PCB as shown in the picture to the right.

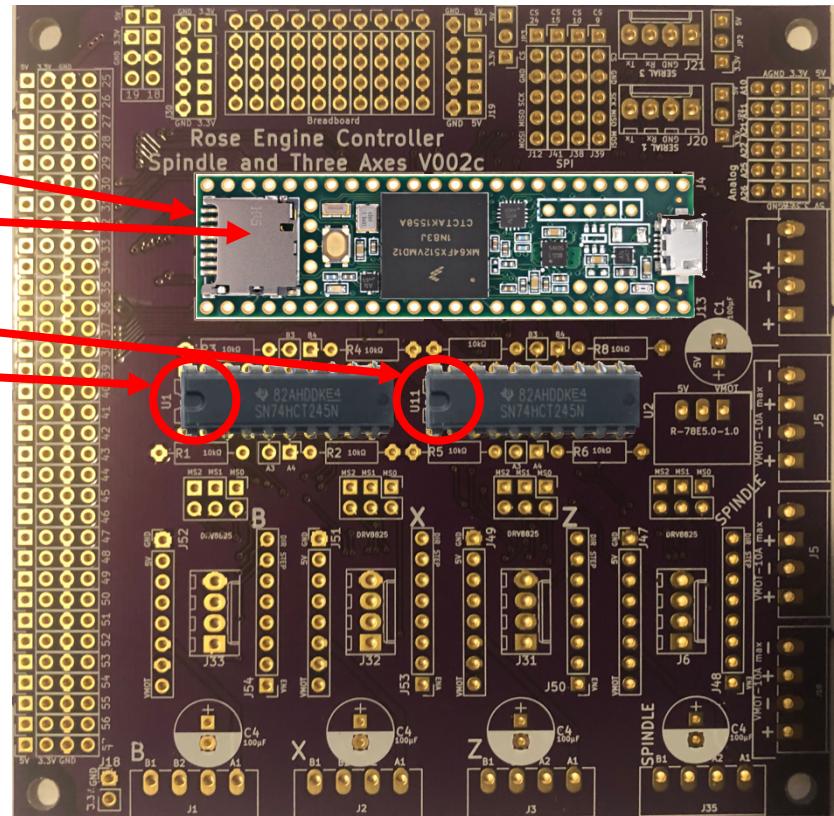
**NOTE:** Recommend using a Sharpie to write on the top of this area what type of Teensy is being used (e.g., 3.5 or 3.6). That will be helpful when upgrading later.

The two 74HCT245 integrated circuits are installed as shown in the picture to the right. Note that the indicating mark should be on the left side as shown here.



MicroSD Extension Cable

A microSD extension cable, 8 to 12 inches long, is useful. The male end can be put into the Teensy's microSD slot, and the female end can then be hung out of the case. This makes it easier to access files for the screens where that function is possible.



# MDF Rose Engine Lathe 2.0

## Build Instructions – Control System for Multiple Stepper Motors

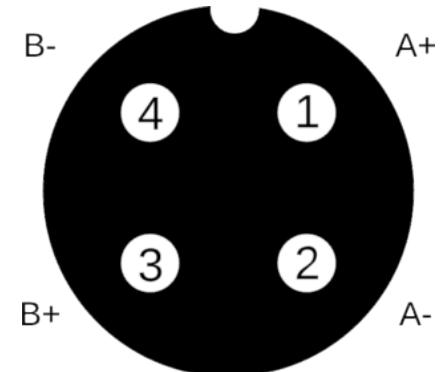
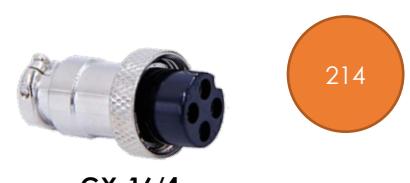
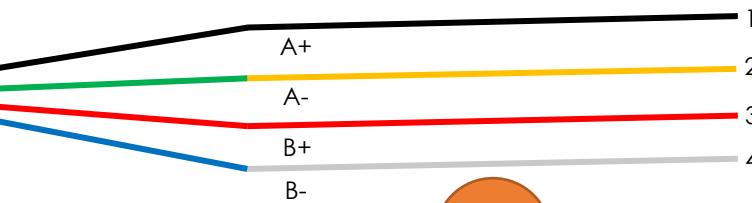
### Section 7 – Stepper Motor Cables

Each of the stepper motors is connected to the stepper motor drivers via GX-16/4 plugs. Stepper motor wire colors shown are for the StepperOnline motors. Check that the one you use matches for the connection needed.

Stepper Motor	Stepper Motor Wire	Cable Wire Color	GX-16/4 Pin
A+	Black	Black	1
A-	Green	Yellow	2
B+	Red	Red	3
B-	Blue	White	4

Yes, I am a Packers fan

Conductor Type	Stranded copper
Conductor Size	20 AWG
Cable Size	4 conductors / cable
Cable Length	
Spindle	4 ft
Others	3 ft, or as desired



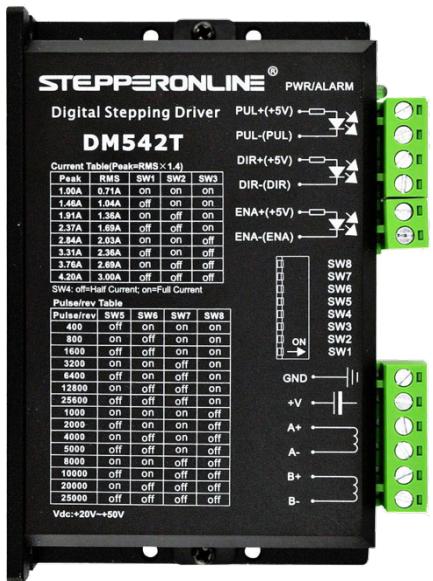
Put a 3/4" long piece of shrink file onto each one of the stepper motor wires before connecting it to the cable 5 wires.

**Best Practice:** Before soldering the wires together, check end-to-end connectivity

1. Connect the stepper motor's GX-16 plug to the jack on the control box.
2. Perform a continuity test on each wire to ensure it is correctly thru the jack and all other soldered joints.

# MDF Rose Engine Lathe 2.0

## Build Instructions – Control System for Multiple Stepper Motors



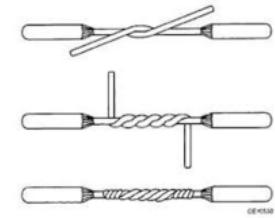
Check continuity of each wire before attaching to the DM542T and the stepper motor wires.



**NOTE 1:** It is a very good practice to perform a continuity test to ensure the pins are wired correctly (i.e., pin 1 in the GX-16 plug should be connected to the A+ wire from the stepper motor).

Connect the cable wires to the stepper motor wires using a lineman's splice (AKA, the Western Union splice, and shown to the right), and then solder the two together.

Heat the shrink file tubing around each of the joints to insulate it from the other things it could touch.



**NOTE 2:** Wires can change colors and positions from time to time.

# MDF Rose Engine Lathe 2.0

## Build Instructions – Control System for Multiple Stepper Motors

Alternatively, you can add a back cover to the stepper motor. This gives a secure way to attach the signal wires to the motor. These are available from a number of sources, and they can even be 3D printed. Look for one online using the term “stepper motor back cover”.

In this case, connect the stepper motor to the GX-16/4 jack as:

Stepper Motor	Stepper Motor Wire	GX-16/4 Pin
A+	Black	1
A-	Green	2
B+	Red	3
B-	Blue	4



# MDF Rose Engine Lathe 2.0

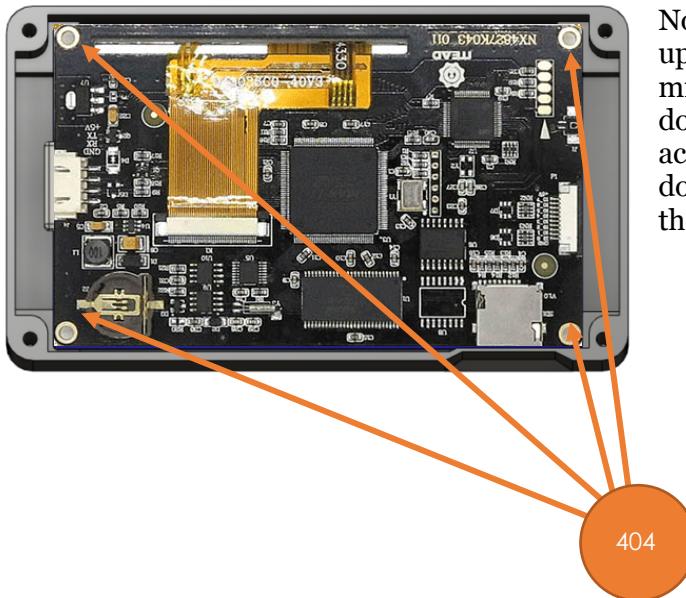
## Build Instructions – Control System for Multiple Stepper Motors

### Section 8 – Assembly of the Nextion touch screen Box

#### Attach Nextion Display to the Bezel

One hole is printed into the back side of the bezel for attaching the Nextion touch screen (circled in red to the right). That one needs to be enlarged using a #39 drill to a depth of  $\frac{1}{8}$ ".

Attach one corner of the Nextion touch screen using an M3 Thread Forming Screw, then center the HMI. Drill the other 3 corners, and then attach the display using the remaining M3 Thread Forming Screws.



Note that the Nextion is inserted upside down. This is because the microSD card slot is then pointed down. And the microSD card slot is accessible so that upgrades can be done without having to disassemble the whole system. (The slot for inserting the microSD card is in the base, not the bezel.)



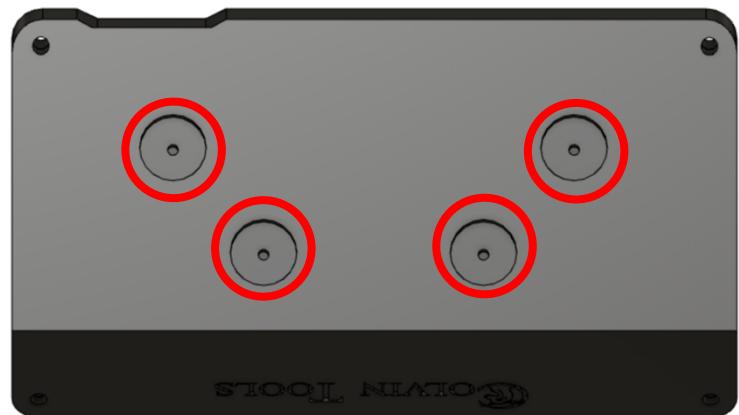
# MDF Rose Engine Lathe 2.0

## Build Instructions – Control System for Multiple Stepper Motors

### Attach Parts to the Base

Attach the 4 magnets to the base's bottom. There are 4 insets in the base for these.

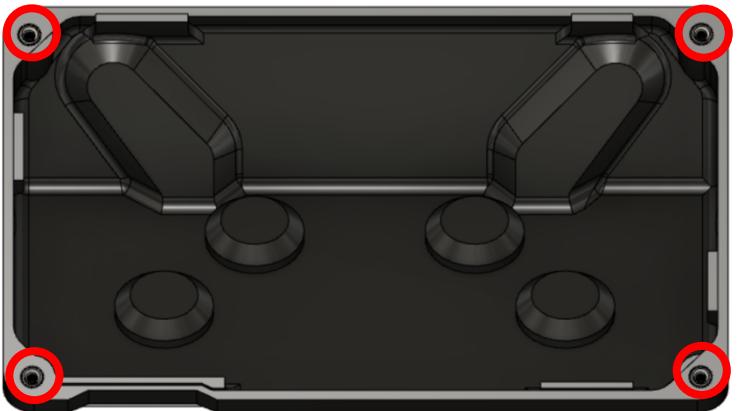
If the screws protrude into the base, take some efforts to grind or file those sharp points down.



### Insert the Heat-Set Inserts

There are two options here:

1. Using a heat gun, insert each of the heat-set inserts into the corners of the base. These would then be used to attach the top of the case using the 4-40 screws (#403).  
An orange circular component labeled "402", representing the heat-set insert.
2. Do nothing at this point, and attach the top using thread forming screws (#410)



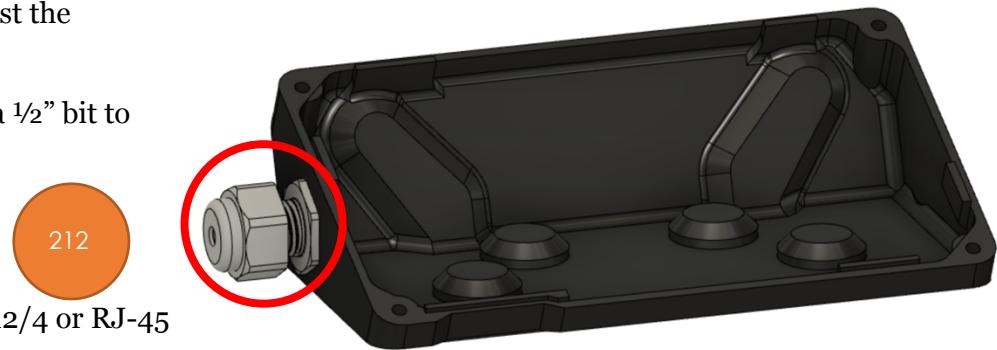
# MDF Rose Engine Lathe 2.0

## Build Instructions – Control System for Multiple Stepper Motors

### Add Wire Cord Grip

The cord grip is used to ensure the signal wire does not pull against the Nextion display.

Depending on the printing, you may need to drill the hole with a 1/2" bit to ease the installation.



### Signal Wiring – PCB to GX-12/4 or RJ-45 Plug for Nextion Display

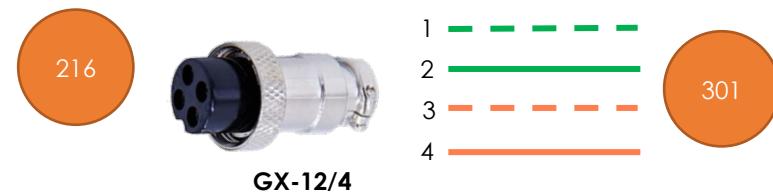
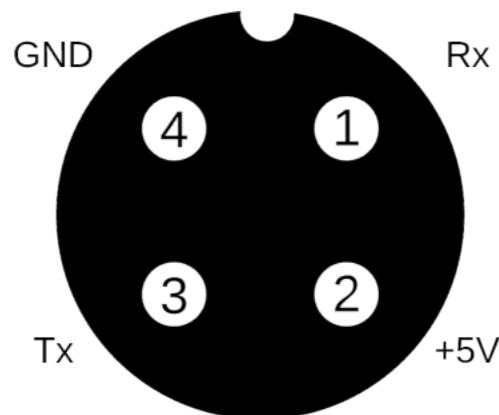
The Nextion touch screen is connected to the main box via a GX-12/4 or RJ-45 connector.

Using a piece of CAT 5 (or greater) wire, 8 feet long, make the connections to the HMI's connector (supplied by the vendor) as shown to the right.

**NOTE 1:** Be sure to put the cable thru the cord grip (#212) before attaching both ends.

**NOTE 2:** Be sure to add a short piece of shrink tubing to the CAT 6/5 wire before finishing the soldering to the GX-12/4 plug (#216). This shrink tubing is needed to secure the plug to the Wire (#301).

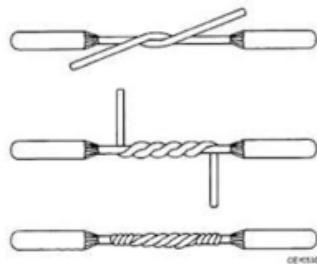
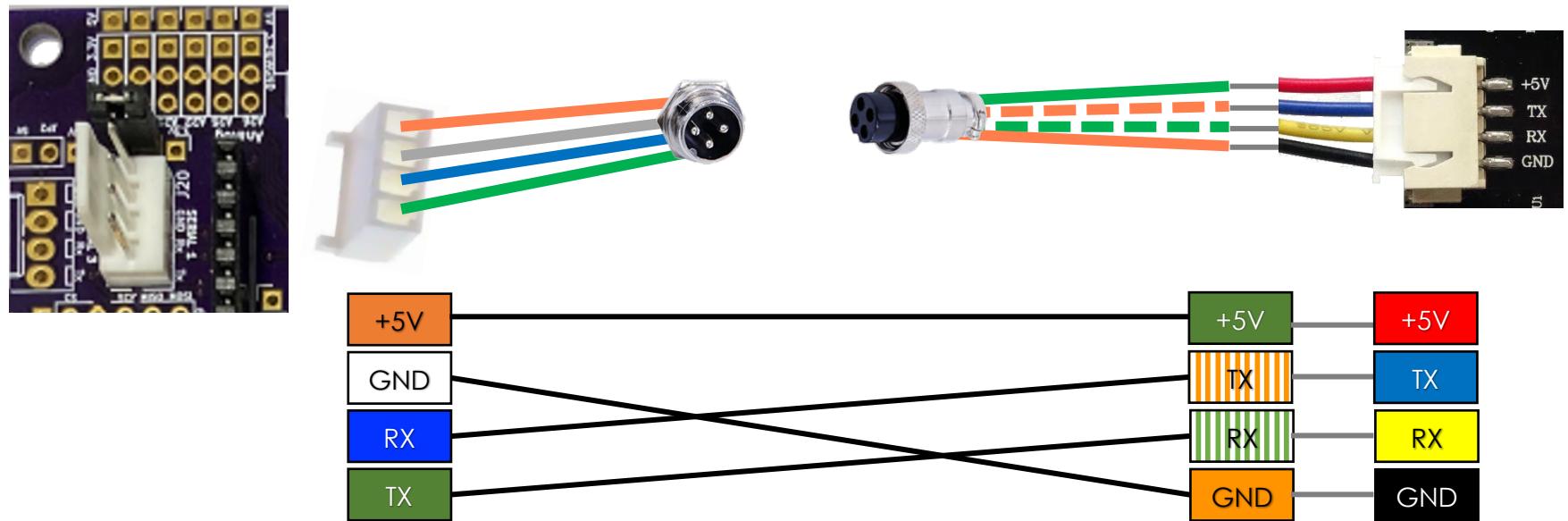
Nextion Connection	Nextion Wire Color	CAT 5 Wire Color	GX-12/4 Pin	RJ-45 Pin
RX	Yellow	White/Green	1	1
+5V	Red	Green	2	2
TX	Blue	White/Orange	3	3
		Blue	4	4
		White/Blue	5	5
GND	Black	Orange	4	6
		White/Brown	7	7
		Brown	8	8



# MDF Rose Engine Lathe 2.0

## Build Instructions – Control System for Multiple Stepper Motors

**Best Practice:** check the continuity on the wires for the Nextion before soldering them into place and especially before heating the shrink film.



Put a 3/4" long piece of shrink file onto each one of the Nextion wires before connecting it to the CAT 5 wires.

Connect the CAT 5 wire to the Nextion wires using a lineman's splice (AKA, the Western Union splice, and shown to the right), and then solder the two together.

Heat the shrink file tubing around the joint to insulate it from the other things it could touch.

Lineman's Splice

# MDF Rose Engine Lathe 2.0

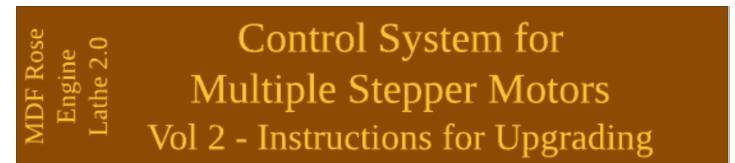
## Build Instructions – Control System for Multiple Stepper Motors

### Section 9 – System Setup and Program Loading

Use the web page noted below to load the programs into the Teensy and the Nextion, and then load the initial configuration into the Teensy.

<https://mdfre2.colvintools.com/NextionUserGuide-Upgrading.html>

If you are looking for that book on the MDF Rose Engine Lathe 2.0 Library, it is just like the book shown to the right.



### Section 10 – Finishing It Up

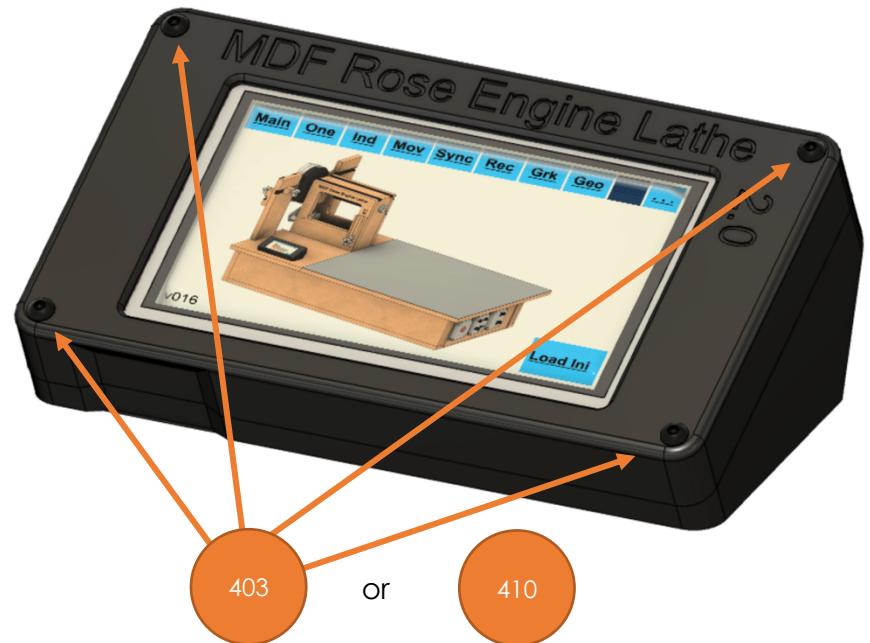
Before screwing the bezel to the base, check to be sure everything works. To do that, you will need to use the instructions in the next section to load the programs into all the pieces.

If it works, screw the two pieces together.

If you took the option to use the heat set inserts back on pg. 43, then attach the lid using four #4-40, 3/4" long screws (#403).

Otherwise, attach it using 4 thread-forming screws (#410).

When finished and powered on, it will look like the picture to the right.



# MDF Rose Engine Lathe 2.0

## Build Instructions – Control System for Multiple Stepper Motors

### Optional Configurations

If you wish to change the designs built into this system, options are outlined below. **We do not support systems with such changes, so the user must be aware that they will be responsible for their own technical support.** These options are only provided for the sake of completeness and transparency.

#### Option 1: Less Functional Model

Some have expressed the desire to build a system which is not as fully functional as outlined in this document. For example, they only want to drive the spindle.

That is very doable but is not an option we will be providing. The components which can be left out when building the system are outlined in the table below.

Component	Configuration			
	Spindle Drive Only	+ Z Axis	+Z & B Axes	+Z, X, and B Axes
10 KΩ Resistors	4	4	8	8
74HCT245s & 20-pin DIP sockets	1	1	2	2
DM542T Stepper motor drivers & GX-16/4 Jacks	1	2	3	4

Regarding limit switches, none are truly required. These can be added later as desired. If not used, the 3.5mm audio jacks are not needed.

#### Recommendation

Except for the DM542T Stepper Motor Drivers, there really is not any significant cost advantage to taking this approach. So, if you do desire to make such a change, consider populating the Printed Circuit Board fully (8 resistors and two 74HCT245s). The DM542Ts can be added when you later want to expand to use them.

# MDF Rose Engine Lathe 2.0

## Build Instructions – Control System for Multiple Stepper Motors

### Option 2: Alternative Stepper Motor Drivers

The printed circuit board was developed to use either

- the DM542T external drivers outlined above, or
- the Pololu DRV8825 stepper motor drivers which would be attached to the board using header sockets.

#### Advantages to Using the Pololu DRV8825

1. DRV8825s are about 1/3 the cost of an external driver (i.e., the DM542T).
2. Having the DRV8825s mounted to the printed circuit board makes for a smaller physical footprint, enabling it to be installed easily inside the lathe's bed carcass.
3. The power draw for this configuration is lower, so a different (& potentially less expensive) power supply is possibly available.
4. There is less cabling to be done.

#### Disadvantages of Using the Pololu DRV8825

1. DRV8825 chips are limited to a max 1.5 A (vs. 4.2 A for the DM542T drivers).
  - a. This can necessitate the need for different, more expensive stepper motors. The cost of these different motors can erode the savings for not using the external stepper motor drivers (DM542T).
  - b. It is easy to overload the DRV8825 chips and cause them to fail.
  - c. It is easy to overload the DRV8825 chips and they in turn can cause other components to fail (e.g., the Teensy).
2. DRV8825 chips get hot when used, so fans must be attached to them to ensure they do not overheat. And the user will need to replace the fans when they fail.
3. Future deliverables (e.g., a curvilinear slide and a spherical slide) for the MDF Rose Engine Lathe 2.0 will be tested to ensure compatibility with the design from above. If the add-on devices do not work with the changed configuration, the owner/builder will be responsible for accommodating the necessary changes.

#### Recommendation

Unless you are an electrical / automation engineer or have substantial experience in this space, the design outlined with external stepper motor drivers (DM542Ts) will be easier to implement over the long term.

# MDF Rose Engine Lathe 2.0

## Build Instructions – Control System for Multiple Stepper Motors

### Option 3: Different Microcontroller

The printed circuit board was developed to use either

- the Teensy 3.5 outlined above, or
- the Teensy 3.6.

The Teensy 3.6 is 50% faster than the 3.5; however, it will only accommodate 3.3V whilst the Teensy 3.5 will accommodate 5V. Using the 3.5 helps ensure you don't burn out the microcontroller.

As for Teensy 4.0 or 4.1, the library of functions needed to control the stepper motor drivers is not yet complete for those boards. We will re-evaluate those over time.

### Recommendation

Unless you are an electrical / automation engineer or have substantial experience in this space, the design outlined with a Teensy 3.5 is recommended.

# MDF Rose Engine Lathe 2.0

## Build Instructions – Control System for Multiple Stepper Motors

### Option 4: Different Display

The control system was designed for a 4.3" Nextion display. We provide the code for these displays:

- 4.3" Enhanced display,
- 4.3" Intelligent display,
- 5" Intelligent display, and
- 7" Intelligent display.

These all have the same resolution (800 x 600), so the screens can be displayed with no re-programming.

That said

1. The Intelligent displays can cause issues with the Teensy 3.6, so a Teensy 3.5 is recommended.
2. We do not have a 3D printable case for the 5" or 7" displays at this time.

### Recommendation

Use the Nextion 4.3" Enhanced display.

# MDF Rose Engine Lathe 2.0

## Build Instructions – Control System for Multiple Stepper Motors

### Document Version History

Ver	Date	Comment
<b>4.1</b>	15 Jun 22	<ul style="list-style-type: none"><li>• Slight updates for soldering pieces on the 5-axis controller board</li></ul>
<b>4.0</b>	09 Jun 22	<ul style="list-style-type: none"><li>• Added board information for the 5-axis controller</li></ul>
<b>3.4</b>	13 Feb 22	<ul style="list-style-type: none"><li>• Added troubleshooting instructions for the stepper motor direction.</li></ul>
<b>3.3</b>	31 Dec 21	<ul style="list-style-type: none"><li>• Added support information for DM542T v4.</li></ul>
<b>3.2</b>	18 Nov 21	<ul style="list-style-type: none"><li>• Added diagrams to better elucidate the GX jacks and plugs. This is to help with troubleshooting.</li></ul>
<b>3.1</b>	19 Oct 21	<ul style="list-style-type: none"><li>• Added support for the new <b>Rose Engine Controller Spindle and Three Axes V002i</b> printed circuit board.</li></ul>
<b>3.0</b>	19 Aug 21	<ul style="list-style-type: none"><li>• Original document split into 3 parts to allow for different case configurations to be handled easily.</li></ul>
<b>2.1</b>	14 Aug 21	<ul style="list-style-type: none"><li>• Changed pins used for limit switches</li><li>• Added information regarding different Teensy and Nextion displays.</li></ul>
<b>2.0</b>	13 Jun 21	<ul style="list-style-type: none"><li>• This document incorporates changes to the way cables are attached to the PCB. It now shows how to use connectors in lieu of soldering the wires directly to the board.</li></ul>
<b>1.4</b>	10 Mar 21	<ul style="list-style-type: none"><li>• Reorganized a few steps to follow better flow of work.</li><li>• Added notes on using GX-12/4 connector for Nextion display.</li><li>• Updated instructions for loading software to reference web site.</li><li>• Also added a few minor other tweaks.</li></ul>
<b>1.3</b>	01 Jan 21	<ul style="list-style-type: none"><li>• Added item numbers for optional build using a Pololu Tic (this is a separate document).</li><li>• Renamed Document</li></ul>
<b>1.2</b>	15 Dec 20	<ul style="list-style-type: none"><li>• Added parts to the bill of materials</li><li>• Added details on the installation of the 3.5mm phono jacks.</li></ul>
<b>1.1</b>	10 Dec 20	<ul style="list-style-type: none"><li>• Added details for optional configurations.</li><li>• Added information for attaching the stepper motor to the headstock</li></ul>
<b>1.0.2</b>	07 Dec 20	<ul style="list-style-type: none"><li>• Updated p/n for item #204; also updated p/n &amp; qty for item #102.</li><li>• Added note on soldering on 3.5mm jacks first.</li></ul>
<b>1.0.1</b>	05 Dec 20	<ul style="list-style-type: none"><li>• Updated commentary about stepper motor needed.</li><li>• Added information about stepper motor mount, pulleys, and belt.</li><li>• Updated drawing dimensions.</li></ul>
<b>1.0</b>	01 Dec 20	Initial document

To the extent that material may appear to be infringed, we assert that such alleged infringement is permissible under fair use principles in U.S. copyright laws. If you believe material has been used in an unauthorized manner, please contact me at [ColvinTools@Gmail.com](mailto:ColvinTools@Gmail.com).

The layout of the Printed Circuit Board (PCB) is copyright Ed French and is used with his permission.

Permission is not granted to manufacture these for sale.