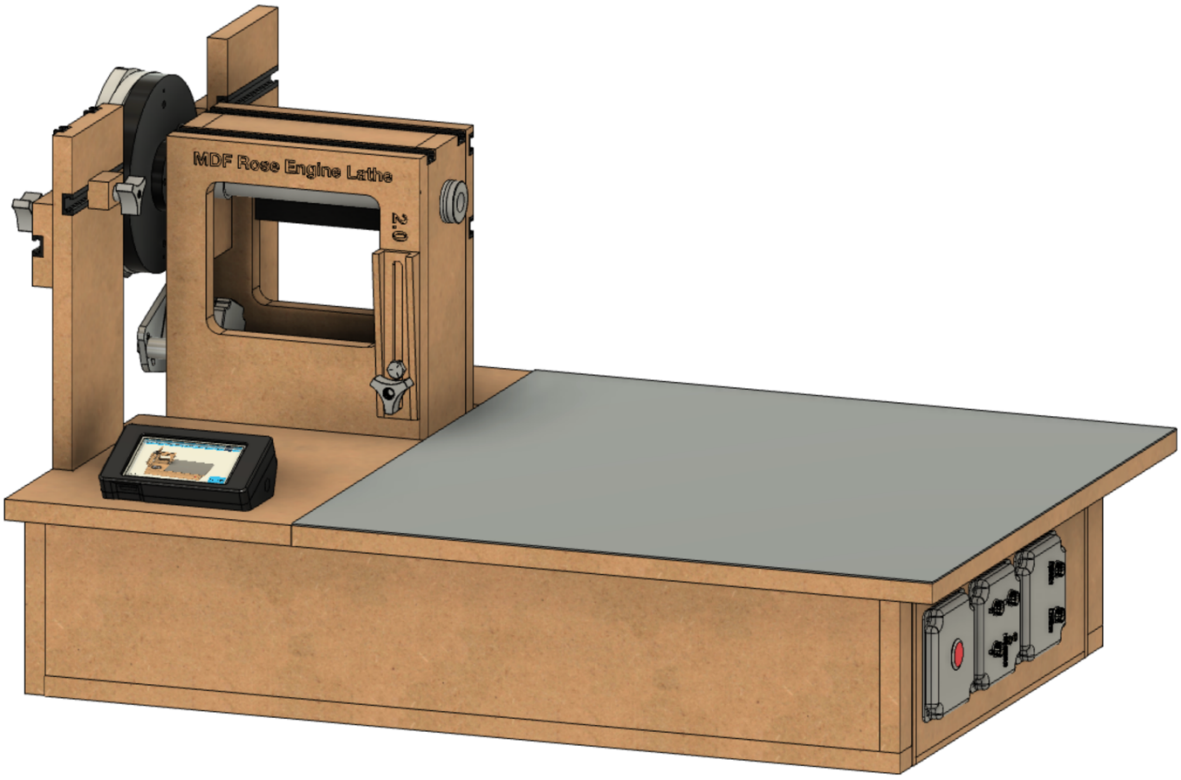
MDF Rose Engine Lathe 2.0
with Stepper Motor Drive



Instructions for Building the Stepper Controls

Version 1.2
15 December 2020

MDF Rose Engine Lathe 2.0

Build Instructions – Stepper Controls

This document is intended to help one unfamiliar with the MDF rose engine to build one easily. It is designed to go with the kit you can purchase from www.ColvinTools.com.

There are some variations from the ideas documented by Jon Magill at www.rogueturner.com. Where this is the case, we have tried to document such changes and provide the reason for the change.

This document is also designed to use a stepper motor for driving the spindle.

If you have any questions, please contact us at ColvinTools@Gmail.com.

Good luck.

Rich Colvin & Jack Zimmel

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Getting Started

As you get started with building this machine, please consider making the machine according to the outlined instructions. There are a boatload of ways you can modify this, and, quite frankly, the MDF rose engine encourages experimentation. But it is best to attempt those modifications after understanding how it works. Some ideas which sound grand may not appear so after understanding how the machine works (we speak from experience).

If you have any questions on the terminology in this document, check out the "Ornamental Turning Book of Knowledge" (www.OTBoK.info).

This document outlines the approach for wiring this machine using:

1. Rose Engine Controller Spindle and Three Axes V002c printed circuit board
2. DM542T Stepper Motor Drivers
3. Nextion 4.3" HMI Display, model NX4827K043

Standards are outlined in a companion document and are used for the compilation of this document.

Cautions

1. **Do not perform any changes to this system when the system is powered on.** Power down and unplug the system before attempting any work.

2. If your local electrical code requires for any differences from what is documented here, those requirements take precedence over this document.

3. If you feel uncomfortable with anything in these instructions, consider having a licensed electrician perform the work.

Please also note: Permission is not granted to manufacture these for sale.

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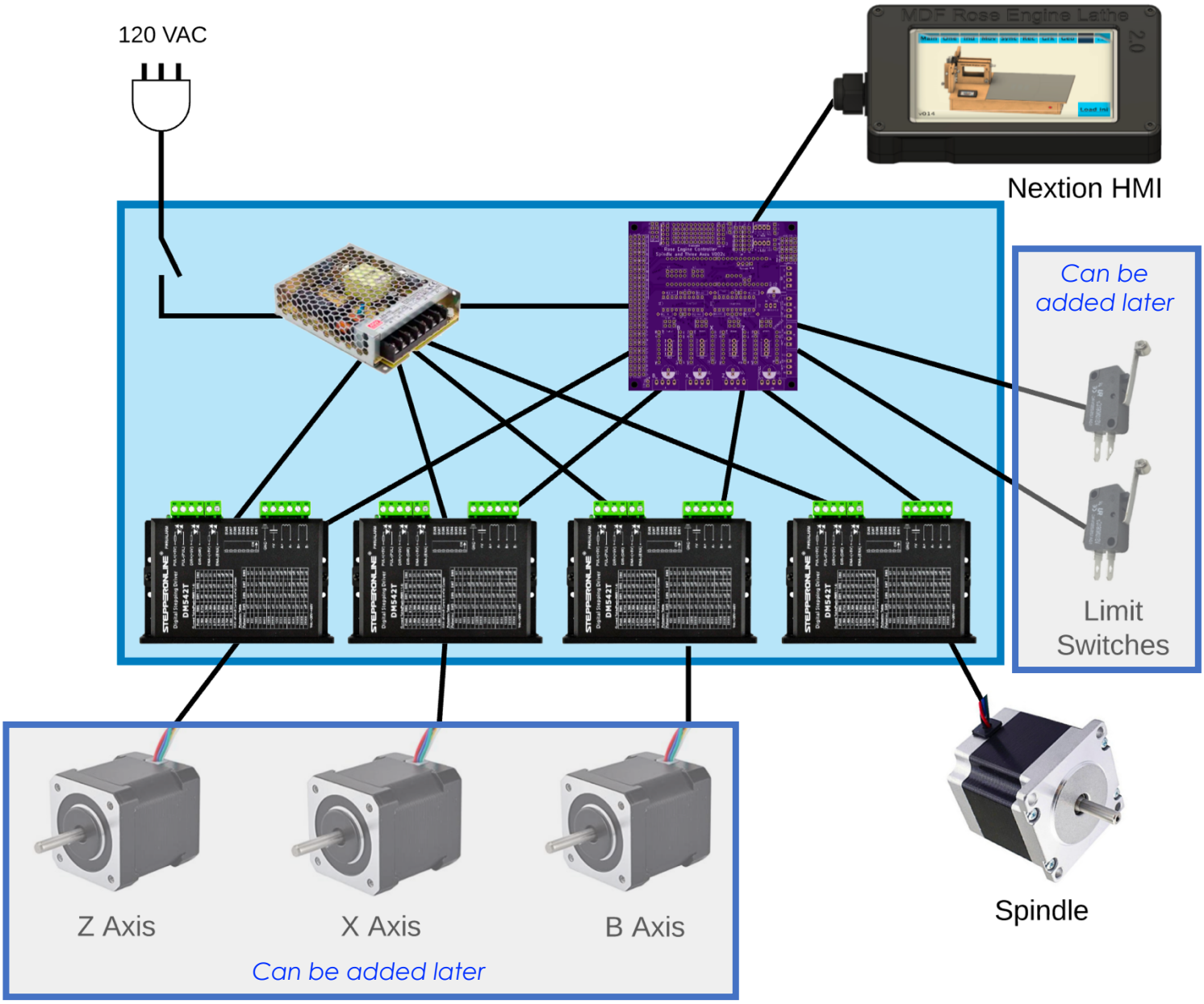
Overview of Connections

The whole system is shown in the picture below.



The system we supply with the MDF Rose Engine Lathe 2.0 Spindle Drive Option includes:

1. Everything in the Controls Box (the box in blue above)
    a. Power cord and on/off switch
    b. Power supply
    c. Printed Circuit Board with all components attached for 4 drives
    d. Stepper Motor Drivers (4 ea.)
    e. Connectors for
        i. Nextion HMI

ii. 4 stepper motors
iii. 6 limit and homing switches

2. Nextion HMI with connecting cable

3. Spindle stepper motor with connecting cable, attaching hardware, drive gears, and drive belt.

The other 3 stepper motors and the two limit switches (and associated attaching cables) are not included but can be added by the user.

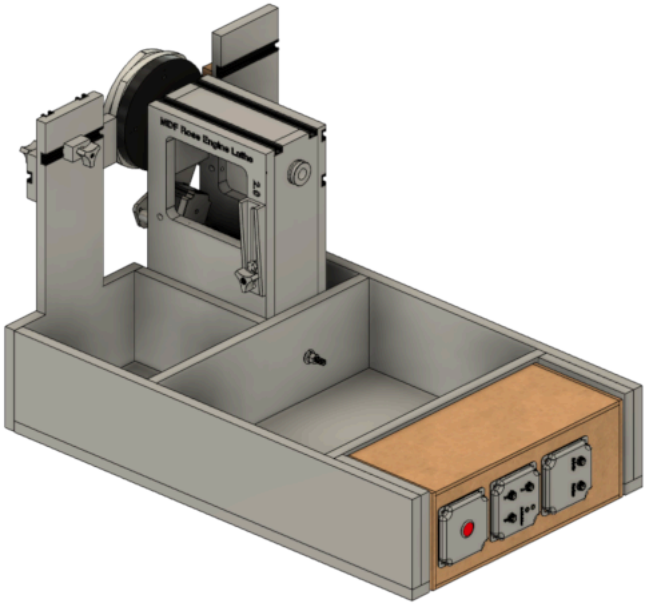
Some have chosen to put the stepper motor controls in the lathe's carcass, under the bed of the lathe. However, placing all the pieces together in a separate box gives these benefits:

1. This controls box is designed be placed under the bed in the MDF Rose Engine Lathe 2.0 (as shown in the picture to the right {the bed cover is removed}).

2. This approach also allows for the controls box to be used with the original MDF Rose Engine Lathe, just placing the box somewhere near the lathe.

3. This also frees up space under the bed for:
   a. Storage of parts or tools, or
   b. Making a gap-bed lathe.

4. The many connections between the various pieces inside the box are already in place and the user does not have to figure out the correct alignment of connectors when building the MDF Rose Engine Lathe.



MDF Rose Engine Lathe 2.0
(B1 and B1A removed)

5. The connections to the stepper motors and limit switches are documented as standards. This allows for the creation of attachments (such as a curvilinear slide) with a built-in stepper motor and connecting it to the controls box.

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.

MDF Rose Engine Lathe 2.0
Build Instructions – Stepper Controls

3

Bill of Materials

Parts required for building this are below. The item numbers are shown in the following drawings using an orange, circled number like the one to the right.

Item #	Item	Qty	Source	Source Part Number	Comments
	Printed Circuit Board Assembly				
101	Printed Circuit Board (PCB)	1	OSH Park	4Rose_002c_Gerbers copy	
102	Header Sockets	2	Digi-Key	S7022-ND	24 pins each – mfgr p/n PPTC241LFBN-RC
103	20-pin DIP sockets	2	Digi-Key	ED3054-5-ND	
104	10 KΩ resistors	8	Digi-Key	CF14JT10K0CT-ND	
105	100 µF electrolytic capacitor	1	LCSC	C59414	Mfgr p/n: KM101M050F115A
106	74HCT245 Octal Bus Transceiver, 3-state	2	Digi-Key	296-1612-5-ND	
107	R-78E5.0-1.0 DC/DC Converter	1	Digi-Key	945-2201-ND	
108	Teensy 3.5	1	PJRC	Teensy 3.5 pins	Be sure to get the one with the pins already soldered into place.
	Electrical Items				
201	AC/DC Power Supply - LRS-100-24	1	Digi-Key	1866-3314-ND	
202	DM542T Stepper Driver	4	StepperOnline	DM542T	
203	Nextion 4.3" HMI Enhanced	1	ITEAD.cc	NX4827K043	
204	Terminal Block, 10 circuits, low profile	1	Mouser	538-39100-1910	Molex is the mfgr; their p/n is 39100-1910
205	Power Switch	1			SPST Toggle

MDF Rose Engine Lathe 2.0

Build Instructions – Stepper Controls

Item #	Item	Qty	Source	Source Part Number	Comments
206	GX-16/ 4 Socket	4			May come as a pair of sockets and plugs (i.e., including #214)
207	3.5mm Audio Jack, Female	6			
208	Utility box cover, 2 gang	2		Hubbell-Raco 804C	
209	Utility box cover, 1 gang	1	Amazon	Hubbell-Raco 861	
210	Utility box cover, 1 gang	1	Amazon	Hubbell-Raco 860	
211	3/8 in. Twin-Screw Cable Clamp Connectors	1	(hardware store)		
212	Cord Grip	2	McMaster-Carr	69915K47	
213	Stepper Motor	1	StepperOnline	23HS30-30045	For the spindle drive NEMA 23 bipolar 1.8° 1.9 Nm, 2.8A, 3.2V 57 x 57 x 76 mm
214	GX-16/ 4 Plug	1	Amazon		May come as a pair of sockets and plugs (i.e., including #206)
	Cables				
301	Cabling – CAT 5 or higher				
302	Cabling – 20 AWG/4, stranded				
303	Cabling – 20 or 22 AWG/2, stranded or solid core				
304	Cabling – 16 AWG/3, stranded				Can cut off the female end of a grounded extension cord.
	Screws, etc.				
401	Nylon Spacer (Unthreaded) for #8 screw – ¼" OD, ¼" length	4	McMaster-Carr	94639A293	
402	Brass Heat-Set Inserts for Plastic, #4-40, 0.170"	4	McMaster-Carr	94459A260	If you take option #1 as outlined on pg. 48, you should use these. If not, they are not needed. These go with #403, below.

MDF Rose Engine Lathe 2.0

Build Instructions – Stepper Controls

Item #	Item	Qty	Source	Source Part Number	Comments
403	Screws, #4-40, ¾"	4	McMaster-Carr	97763A322	If you take option #1 as outlined on pg. 48, you should use these. If not, they are not needed. These go with #402, above.
404	M3 Screws, Thread Forming	4	McMaster-Carr	96817A300	
405	Magnets	4	McMaster-Carr or Amazon	5862K14	½" outside diameter with hole in center for attaching to an object via a screw. Used on bottom of the 3D-printed enclosure for the Nextion HMI display
406	Sheet Metal Screws, #4, 3/4" long, round head		McMaster-Carr	90935A137	These work acceptably in the MDF for the purposes they are designed to be used.
407	Particle Board Screws, #6, 3/4" long, round head		McMaster-Carr	91555A115	
408	Particle Board Screws, #6, 5/8" long, flat head		McMaster-Carr	90252A246	
409	Sheet metal screws, #4, 5/16" long, flat head		McMaster-Carr	90065A107	Used to attach #405 magnets to the 3D-printed enclosure for the Nextion HMI display.
410	Torx Round Head Thread-Forming Screws for Plastic, #4, 7/8" long		McMaster-Carr	96001A217	If you take option #2 as outlined on pg. 48, you should use these. If not, they are not needed.
	Spindle Drive Parts				
501	Timing Belt	1	MiSUMi	GBN655EV5GT-90	GT3 5mm pitch 131T / 655mm long 9mm wide
502	Spindle Pulley	1	Colvin Tools		Attached to the spindle via the flange.

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Build Instructions – Stepper Controls

Item #	Item	Qty	Source	Source Part Number	Comments
503	Stepper Motor Pulley	1	Stock Drive Products (www.sdp-si.com)	A 6A55-012DF0908	Attached to the stepper motor 5 mm (GT2) Pitch,12 Teeth, 0.25" Bore, 2 Flanges / With Hub, Aluminum Alloy Timing Pulley for .354 (9mm)" Wide Belt
504	Stepper Motor Attachment Bracket & Parts	1	Colvin Tools		Includes: • Bracket with Idler • Mounting bolts, nuts, and spacers to attach to headstock • Mounting screws to attach stepper motor
	Touch Screen Parts				
601	Touch Screen Case, 3D printed	1	Colvin Tools		Can also get plans to 3D print this from **elfren**'s repository on GitHub. The folder is **RoseEngine_SpindleAndAxis / Nextion / Enclosure_43**.
	Optional Parts				
901	Limit switch	Up to 6	McMaster-Carr	7779K13	Needs to be normally off with a momentary on.
902	Magnetic Base Stand with Noga Arm		Amazon		For holding the limit switch. Clockwise Tools MGBR-01 is a good one to consider.

Not all screws are shown, only the ones which matter for size or are hard to find.

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Build Instructions – Stepper Controls

Controls Box Enclosure

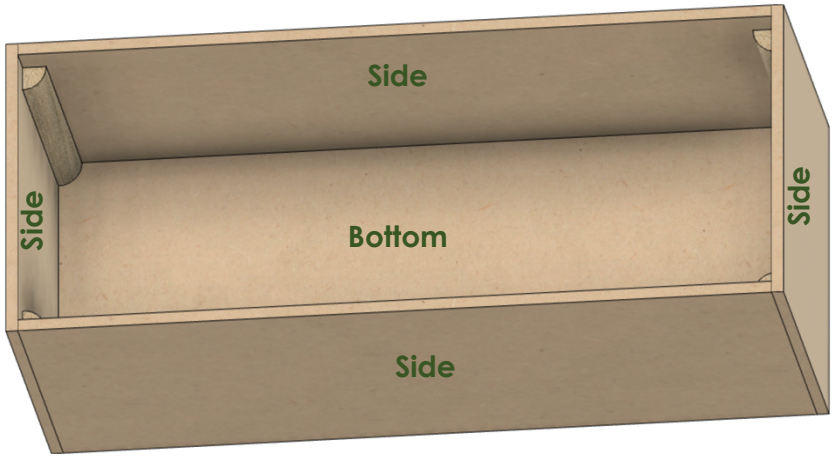
The assembled box has

4. A top and bottom made from ¾" MDF,
5. Four sides made from ¼" MDF, and
6. 4 corner posts made from quarter-round trim.

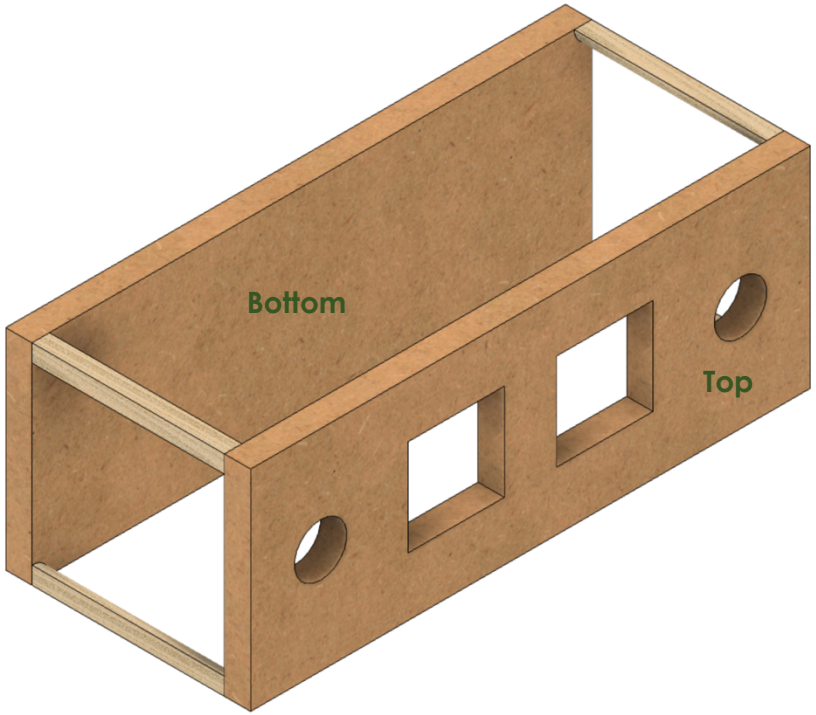
Removing the top reveals the box shown to the right.

The quarter-rounds are used to give the top and bottom something to set the spacing correctly.

The four ¼" thick sides are screwed to the top and bottom.



Replacing the top, and removing the sides reveals the view to the left.



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Build Instructions – Stepper Controls

Before Assembly

The following instructions should be followed before assembling the controls box

Bottom

This is made from ¾" MDF.

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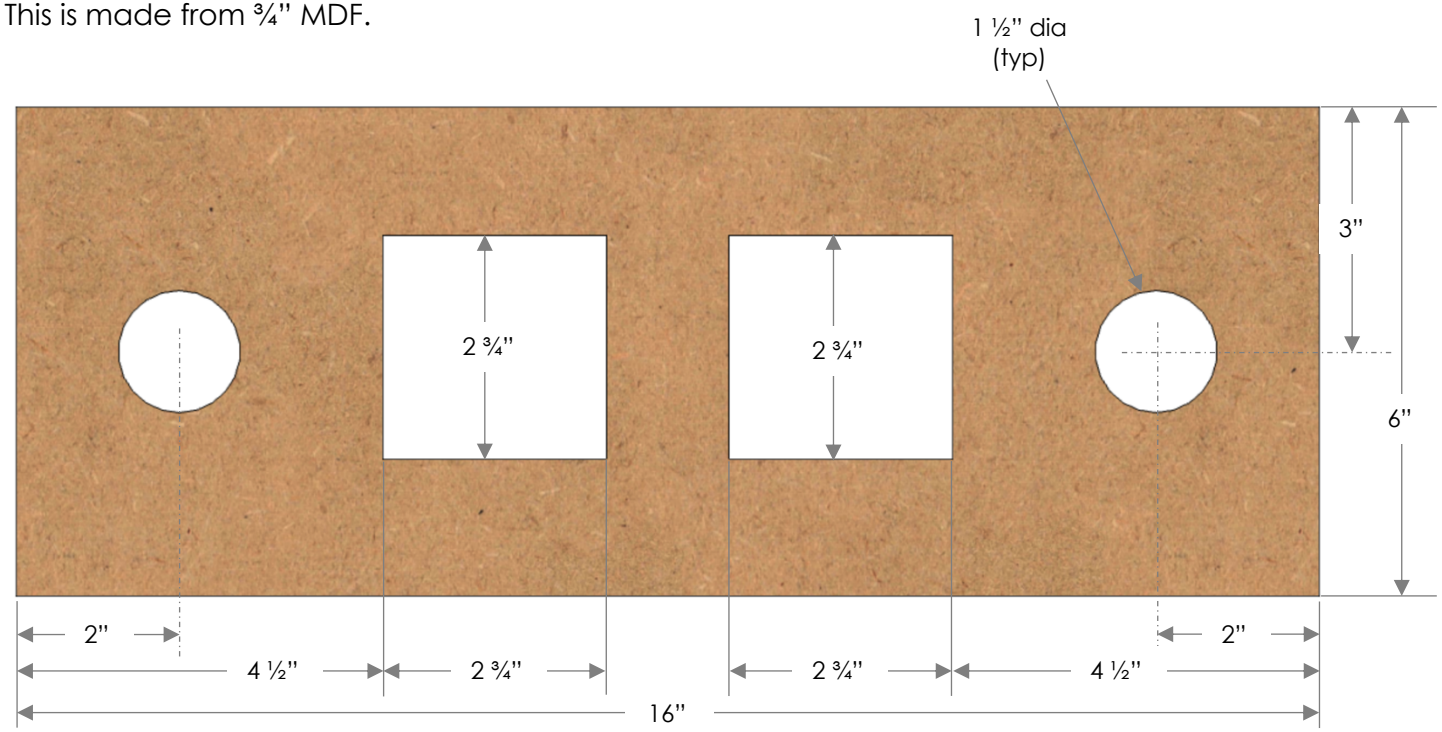
Build Instructions – Stepper Controls

Top

This is made from ¾" MDF.

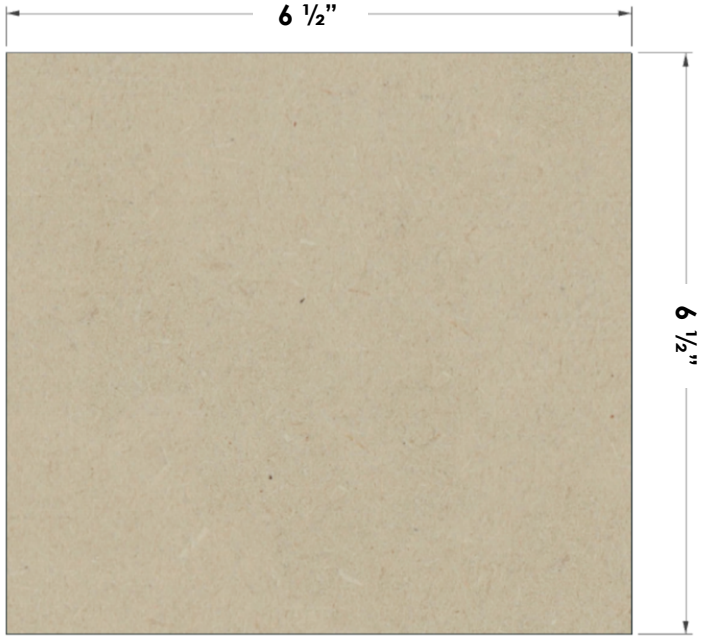


MDF Rose Engine Lathe 2.0

Build Instructions – Stepper Controls

Short Sides (2)

There are two of these, and they are made from ¼" MDF.



MDF Rose Engine Lathe 2.0
Build Instructions – Stepper Controls

Long Sides (2)

There are two of these, and they are made from ¼" MDF.

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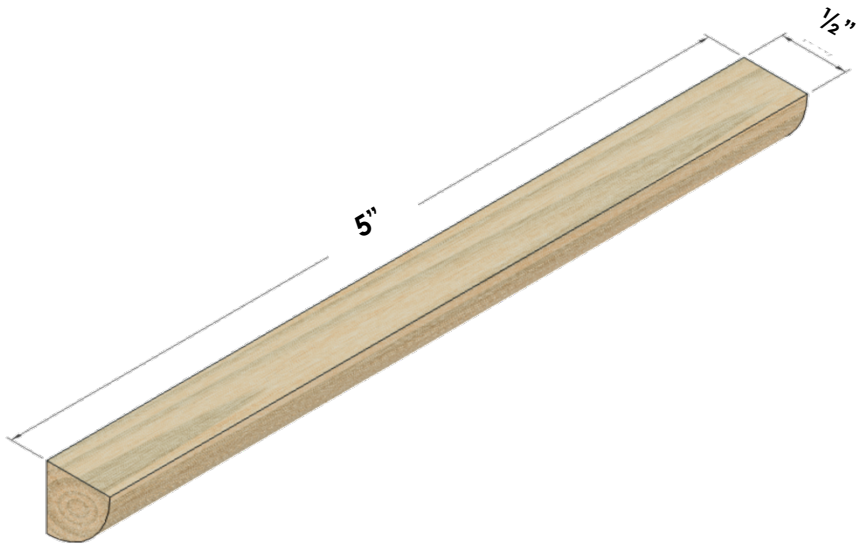
Build Instructions – Stepper Controls

Quarter Rounds (4)

There are four of these, and they are made from any good trim material. These are ½" radius, but that is not terribly critical.



MDF Rose Engine Lathe 2.0

Build Instructions – Stepper Controls

Assembly

Glue the four quarter rounds to the ends of the two long sides. Be certain to:

1. center the quarter round so there is ¾" on each end, and
2. ensure the edges are flush to each other.

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Build Instructions – Stepper Controls

Electrical Plates for Connectors

Power Infeed

Use a 1-gang plate with the hole punched out for the cable strain relief. Secure the power cable in place using the 3/8 in. Twin-Screw Cable Clamp Connector. Wait until later to tighten the screws holding the power cable into place.

211

209

Power Switch

Use a 1-gang plate which is blank. Drill a ½" hole in the center and secure the power switch to it.

205

210

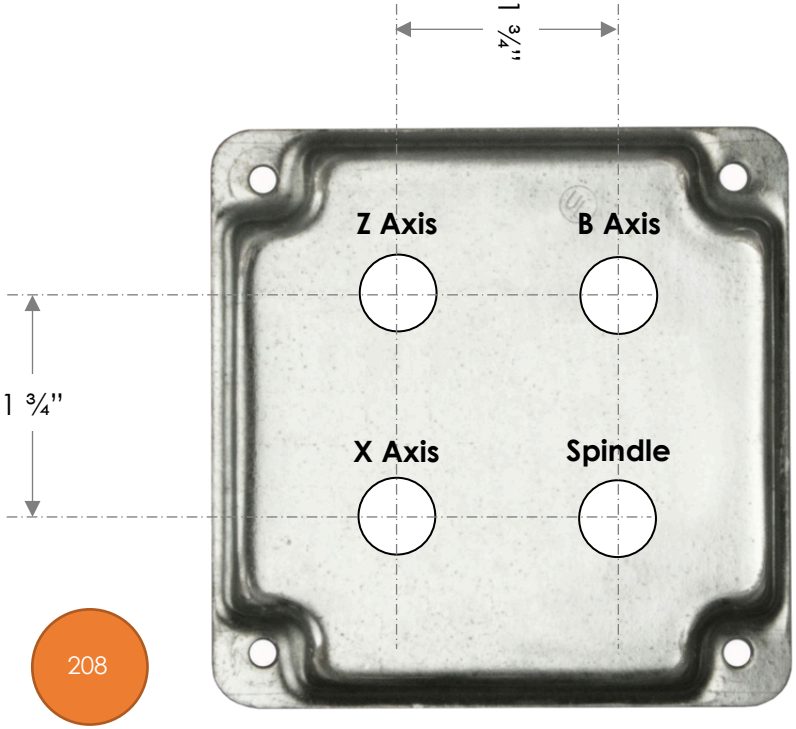
MDF Rose Engine Lathe 2.0
Build Instructions – Stepper Controls

Stepper Motor Plugs

Use a 2-gang plate which is blank. Drill 4 holes which are each $^{5}/_{8}$" diameter.

Label these as:

- Z Axis
- B Axis
- X Axis
- Spindle



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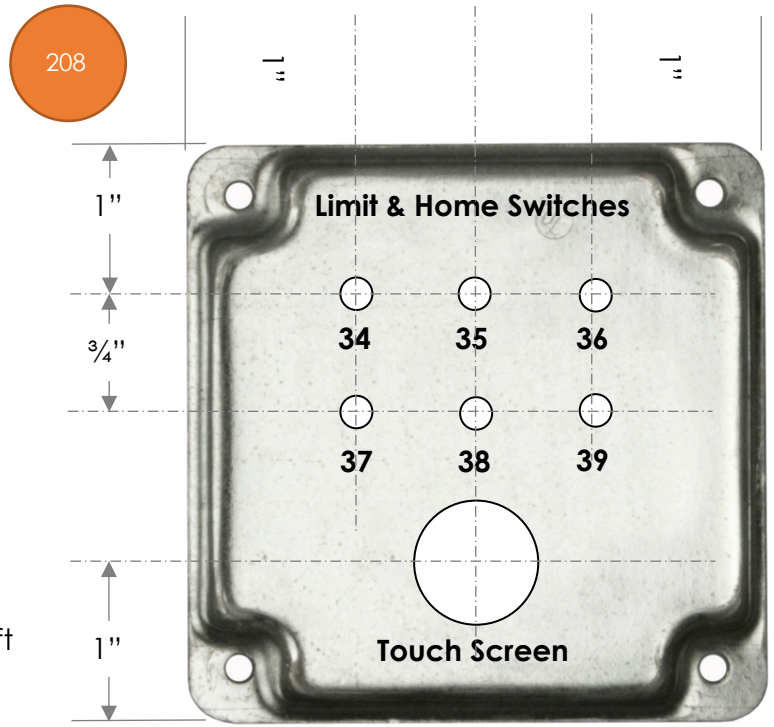
Build Instructions – Stepper Controls

Other Plugs

Use a 2-gang plate which is blank.

Drill 6 holes which are each $^{15}/_{64}$" diameter. Label these as:

- Limit & Home Switches
  - 34
  - 35
  - 36
  - 37
  - 38
  - 39



For the touch screen (the Nextion HMI), there are two options:

1. If you want to use an RJ-45 connector to enable disconnecting the display, then drill 1 hole which is $^{31}/_{32}$" diameter. Center it left to right, and 1" from the outer edge. Label this as:
   - Touch Screen
2. You can pass the cable thru this plate using a cable grip as used on the Nextion Display case. If you pursue this option, drill 1 hole that is ½" diameter. Center it left to right and 1" from the outer edge.

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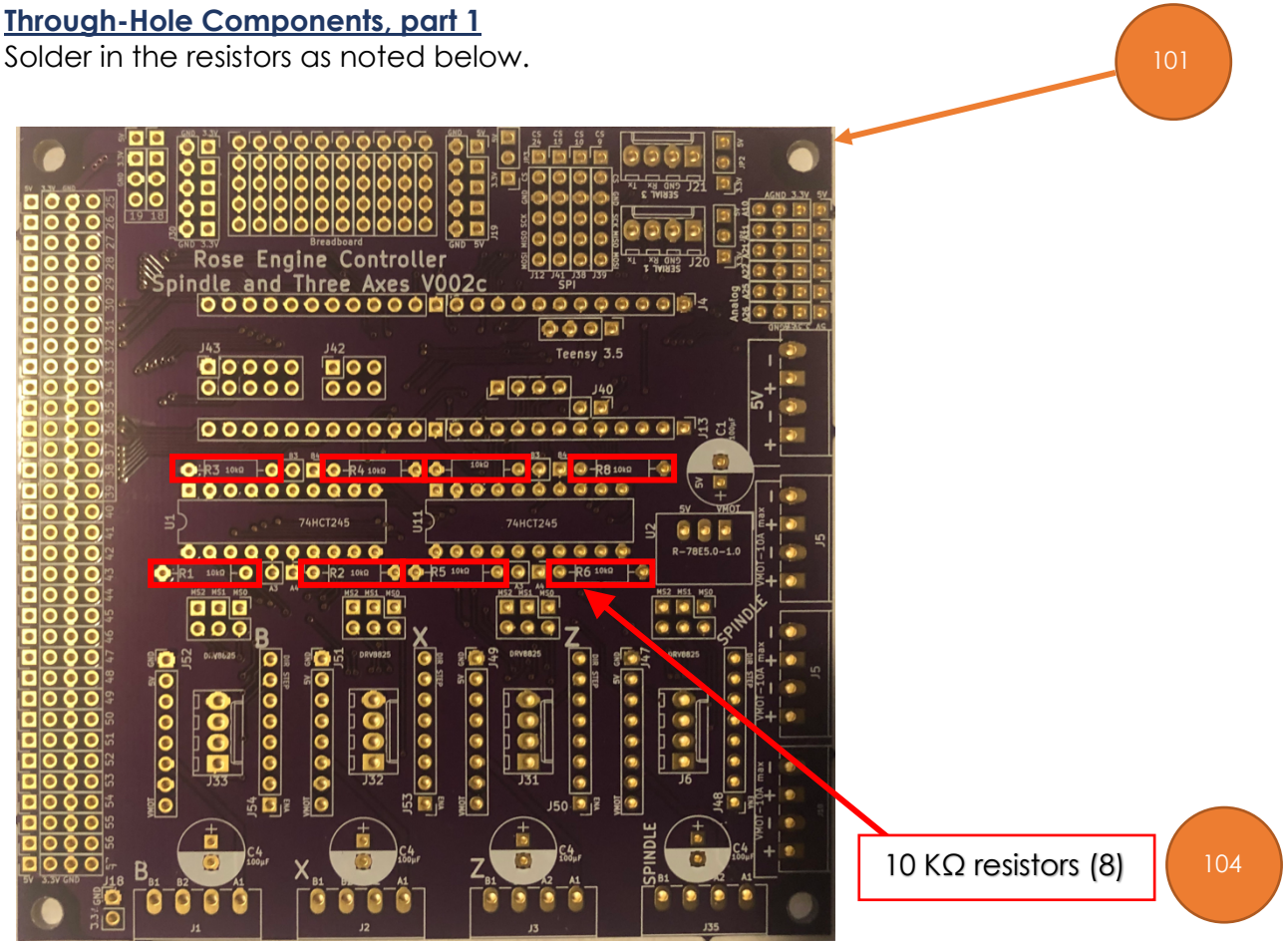
Build Instructions – Stepper Controls

Printed Circuit Board

Attach the parts to the **Rose Engine Controller Spindle and Three Axes V002C** printed circuit board (PCB) using the instructions below.

Through-Hole Components, part 1

Solder in the resistors as noted below.



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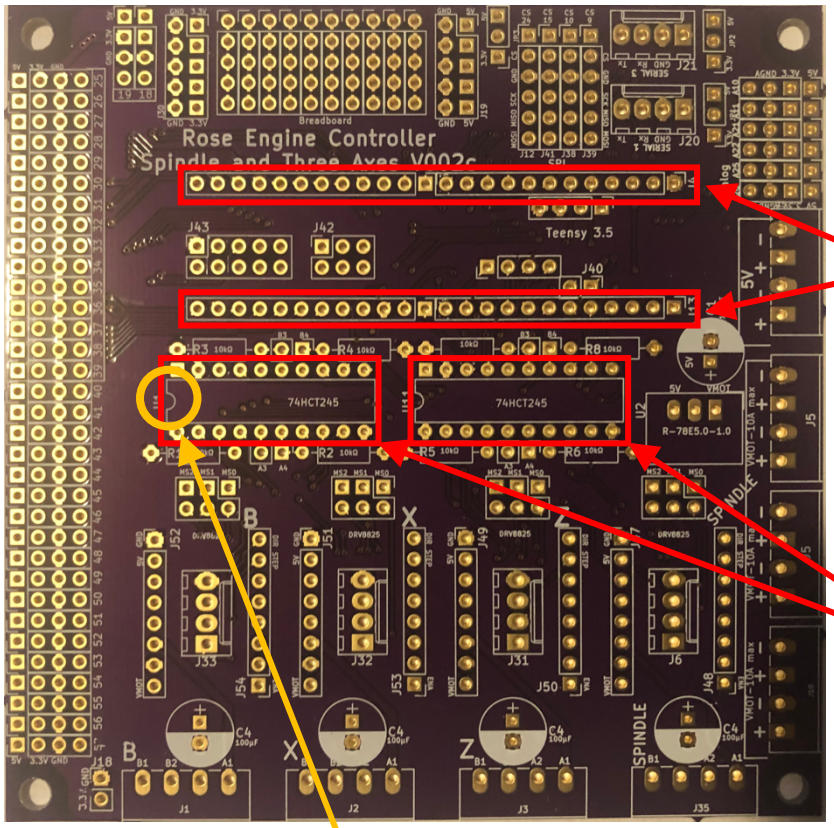
Build Instructions – Stepper Controls

Headers for Integrated Circuits

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



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.

Headers (2) for Teensy 3.5

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.

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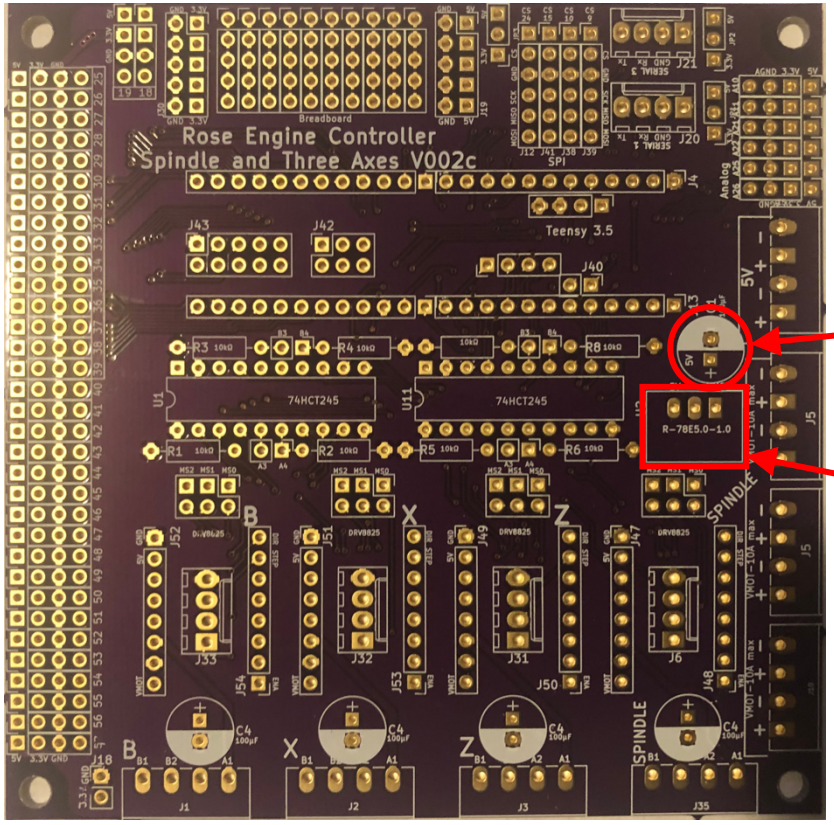
Build Instructions – Stepper Controls

Through-Hole Components, part 2

Solder in the components noted below.



NOTE: Be sure the capacitor is set correctly. The – side goes in the area shaded white.

100 µF Capacitor 105

R-78E5.0-1.0 DC DC Converter 107

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

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Build Instructions – Stepper Controls

Cabling, general

This section is about connecting the PCB to the other components via appropriate cabling. This can be done two ways:

1. Best practice recommendation is to put jacks onto the board and connect the wires via the opposite jack end. If you go that route, do consider making the design "dummy proof". By that I mean,
    a. Use different types of connectors for the Nextion HMI display than for the stepper motors. Both use a 4-wire connection, and you want to prevent the connector being attached to the wrong place. The two typical options are:
        i. Use a male connector on the PCB for one (e.g., the Nextion display), and female connectors for the other (e.g., the stepper motors), or
        ii. Use a 5-wire connector for one, just ignoring the 5th wire option.
    b. Use keyed connectors which prevent the user plugging the cable into the board backwards.

2. The option that can also be taken is to solder the wires directly to the board.
    a. That works well unless the wires are subject to movement which can cause them to break from the PCB. If you plan to disassemble and re-assemble your system often, consider not using this option.
    b. However, this option helps in that the connectors won't jar loose.

NOTES:

1. If you connect the wires to the PCB directly, I recommend soldering the stranded wires into place first. They are the most difficult.

2. Before soldering the stranded wires, be sure to tin the wires first.

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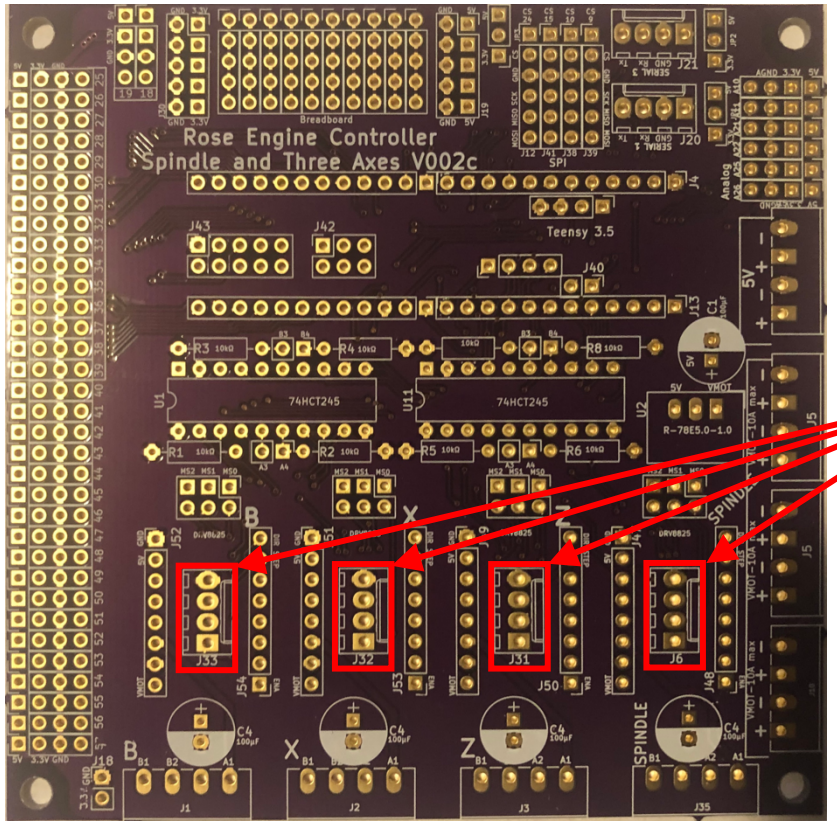
Build Instructions – Stepper Controls

Cabling, part 1

Solder in the cables as noted below.



Cabling for DM542T Drivers (4)
(same for B, X, & Z)

O GND	White
O DIR	Red
O STEP/PUL	Black
☐ ENA	Yellow

Enable is square & closest to the J6 / J31 / J32 / J33 label. The rest are in the order shown in the table.

20 AWG / 4 – Stranded

Cables 8-10" long

302

MDF Rose Engine Lathe 2.0
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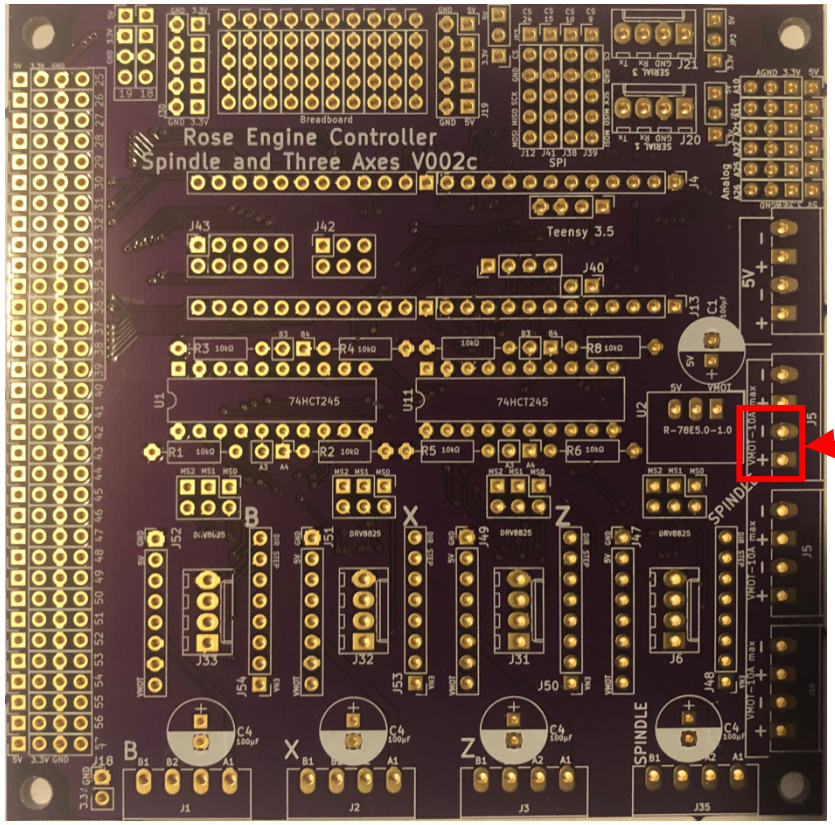
Cabling, part 2

Solder in the cables as noted below.



Cabling for 24 VDC Power Feed	
O -24V	White
☐ +24V	Red
22 AWG / 2	
Cable 15" long	

303

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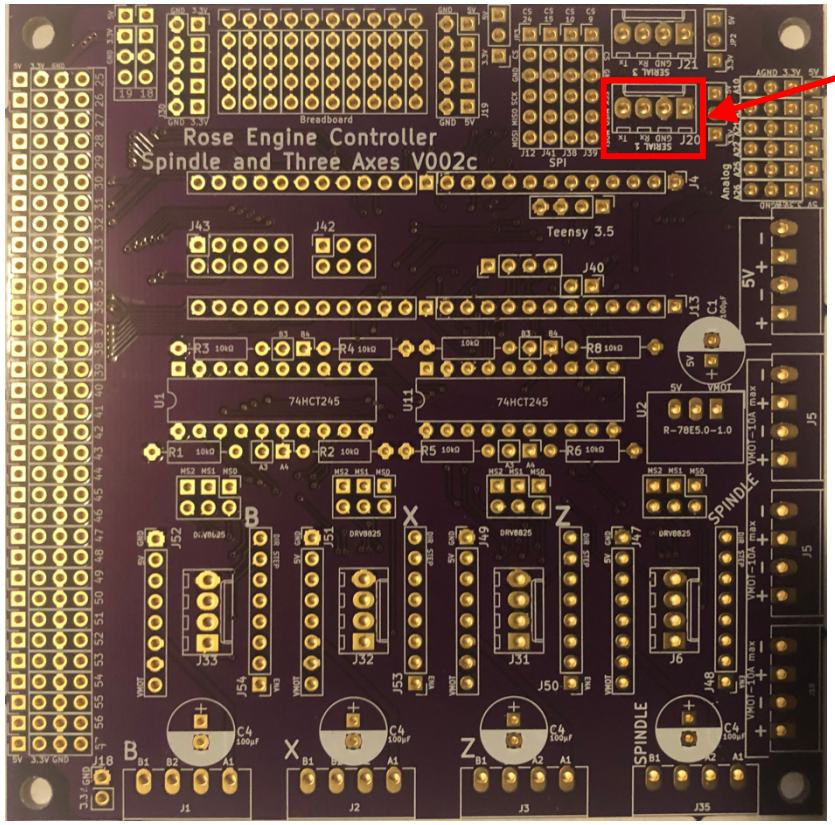
Build Instructions – Stepper Controls

Cabling, part 3

Solder in the cables as noted below.



Cabling for Nextion Display	
O Tx	White/Green
O Rx	White/Orange
O GND	Orange
☐ +5V	Green

+5V is closest to the J20 label. The rest are in the order shown in the table.

Cat-5 or higher

- If connecting thru the panel to the Nextion HMI display (using a cable grip on the panel), 7 feet long. (recommended)
- If connecting to a panel mount connector, 8" long.

301

NOTE:

- Tx on the PCB is connected to Rx on the touch screen.
- Rx on the PCB is connected to Tx on the touch screen

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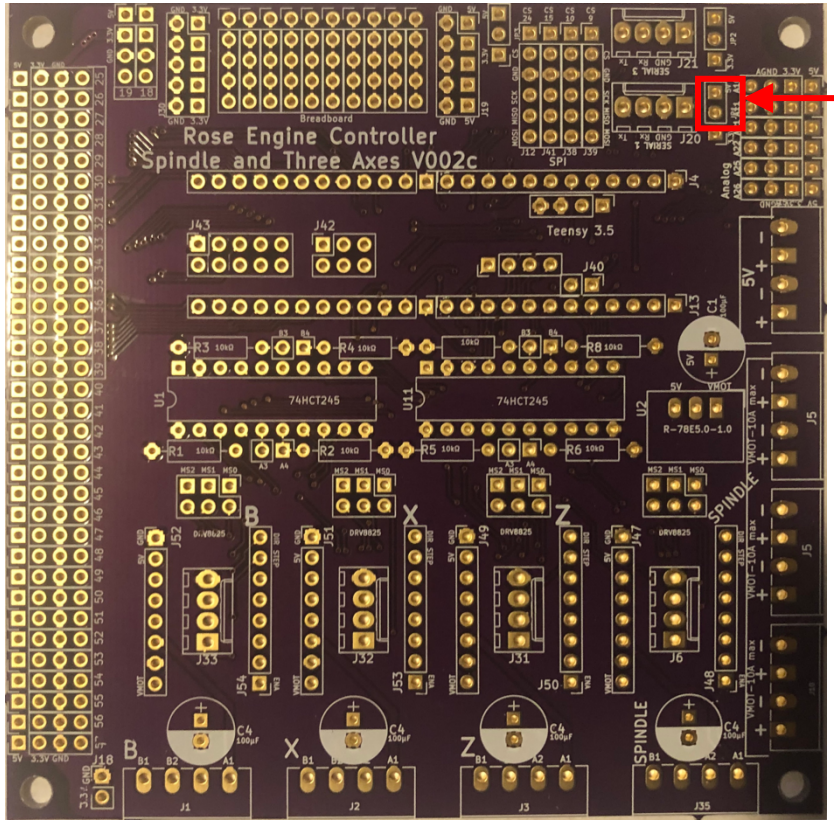
Cabling, part 4

Solder in the cables as noted below.



Jumper for Nextion Power Option	
O JP1	Red or Black
☐ 5V	
22 AWG / 2	
Cable is 1 ½" long	

303

NOTE: If the jumper is not connected, there will be no power going to the Nextion HMI.

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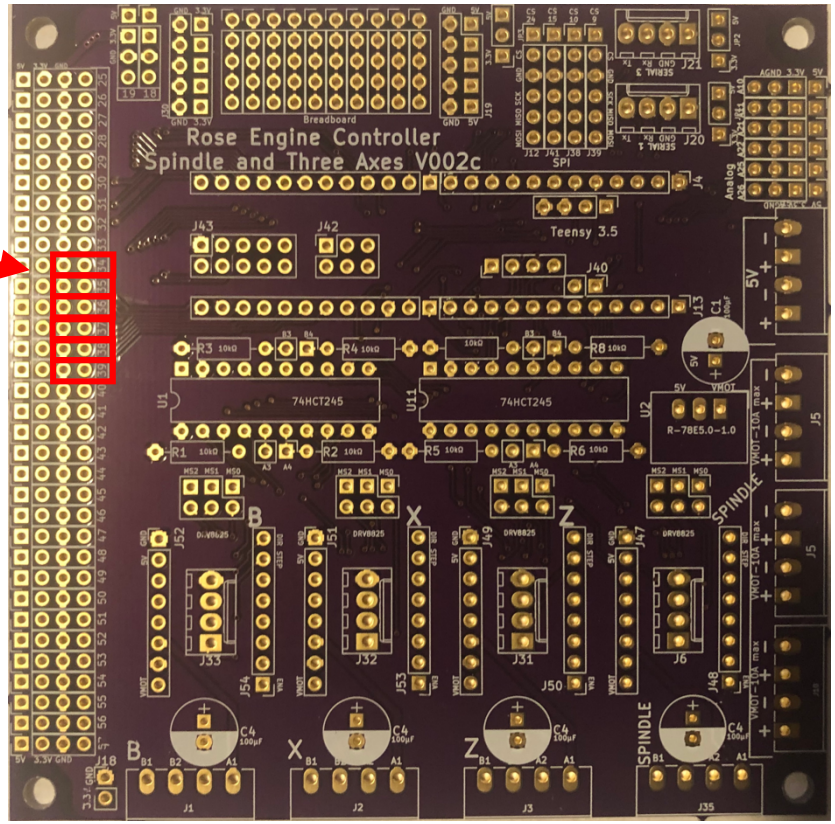
Cabling, part 2

Solder in the cables as noted below.

303

Cabling for Limit Switches (2)	
O Pin #	Red
O GND	White or Black
O 3.3V	(unused)
☐ 5V	(unused)
Pins 34 to 39	
22 AWG / 2 - Stranded	
8" long	



NOTE: it may be easier to attach the jacks to the wires before soldering them into place on the board. If you want to do that, follow the steps on pg. 39 before talking this step.

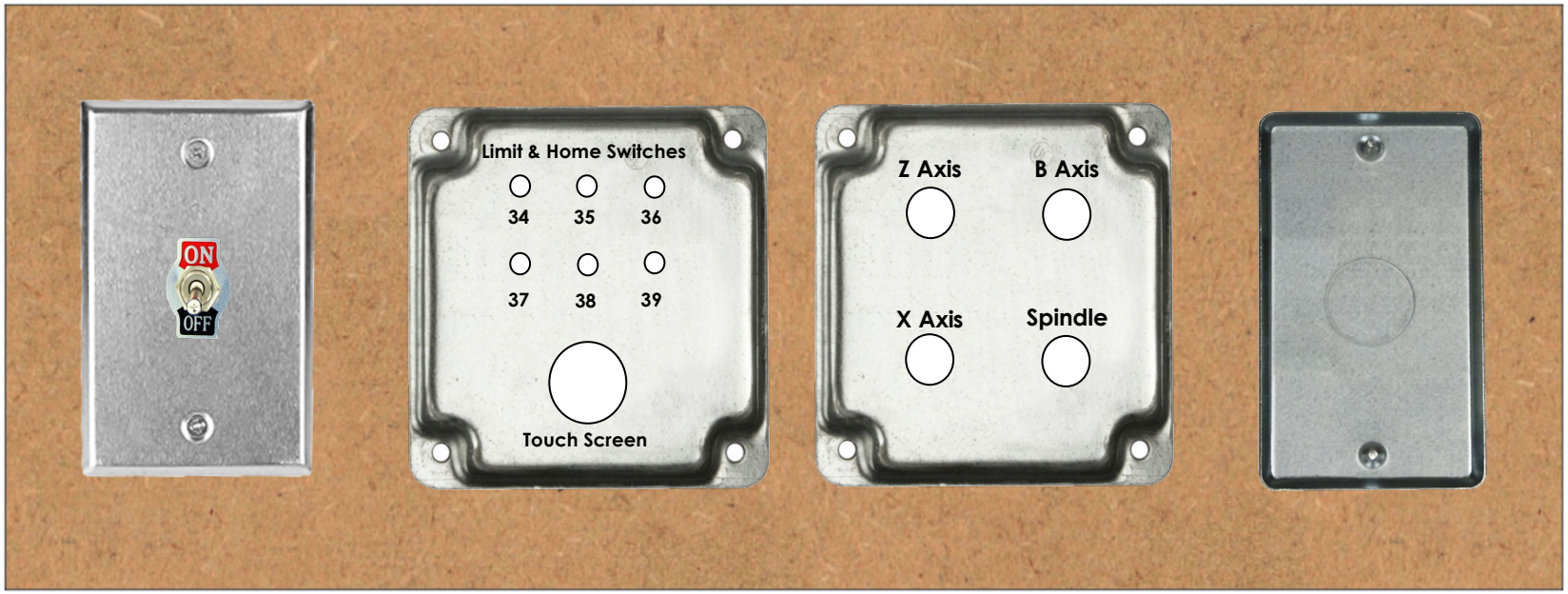
MDF Rose Engine Lathe 2.0

Build Instructions – Stepper Controls

Assembly of the Control Box Electronics

Mounting the Covers

The layout below is recommended. This minimizes cable management issues when used.



NOTE: Screw these plates into place using 5/8" #6, flat head, particle board screws (item #408 in the bill of materials).

408

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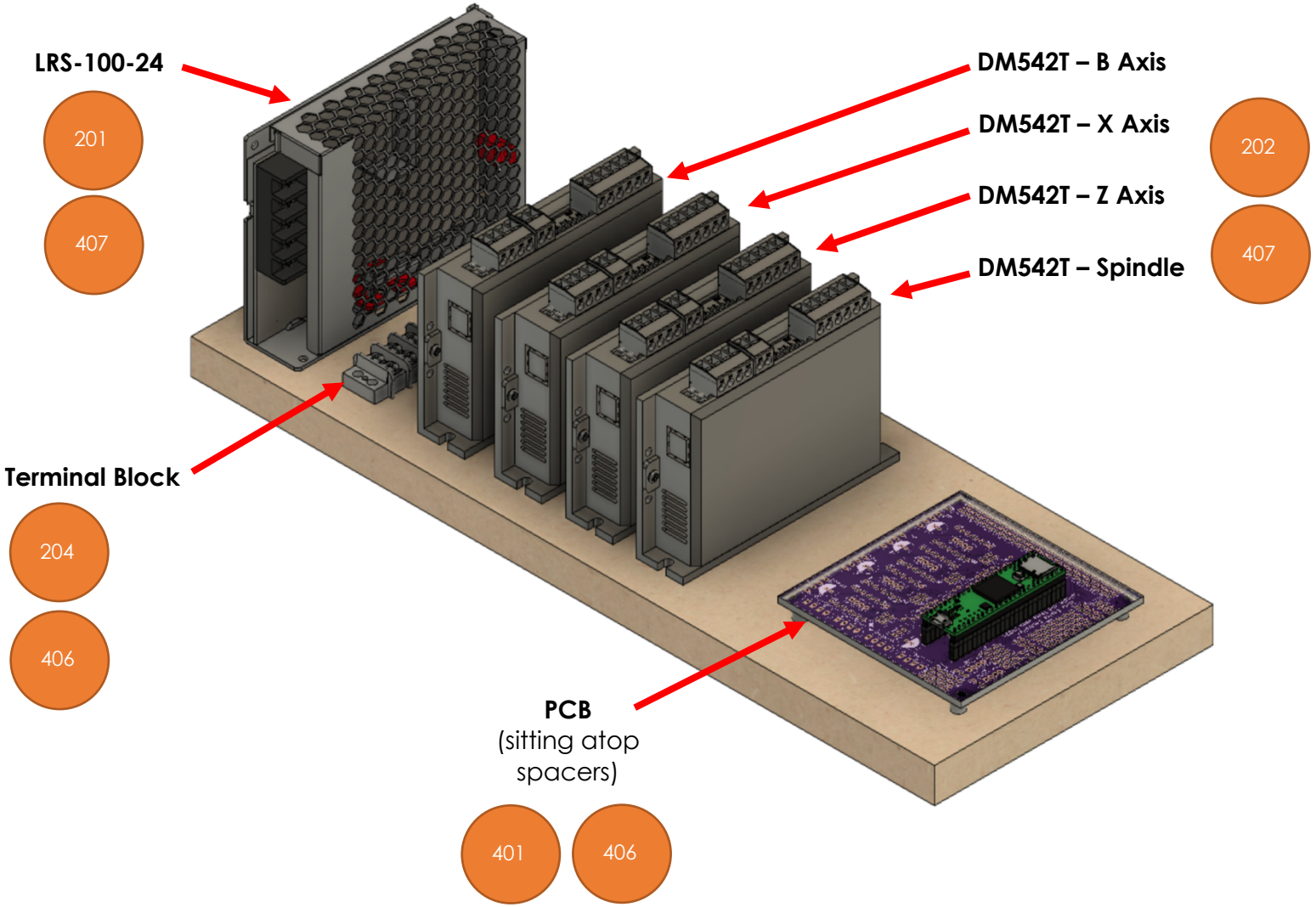
Build Instructions – Stepper Controls

Mounting Electronics to the MDF Base

Mount the electronics to the base piece of the MDF.



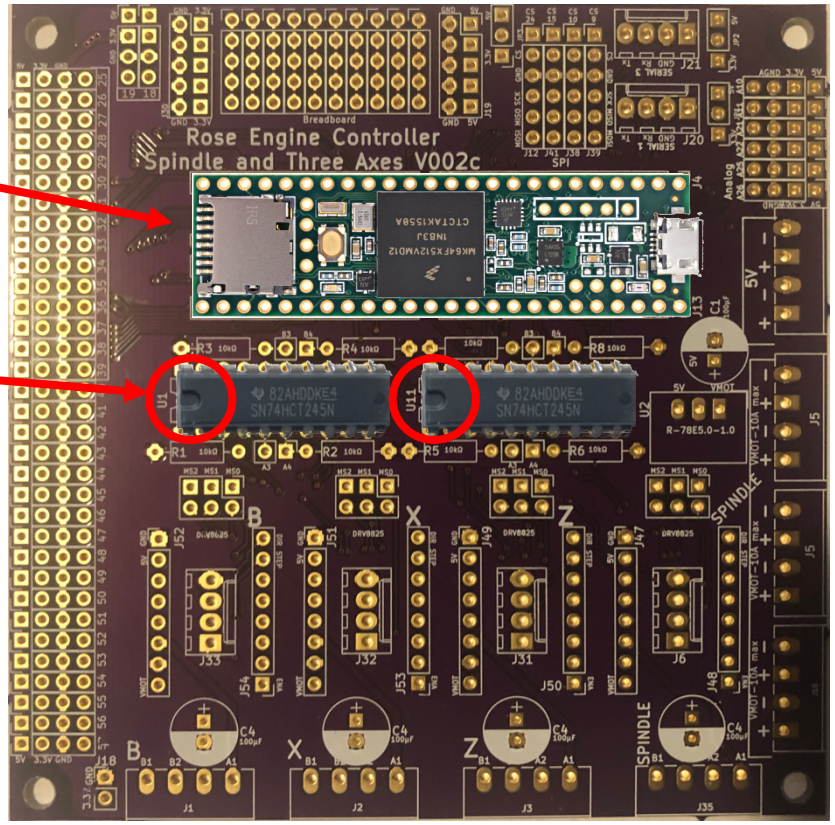
MDF Rose Engine Lathe 2.0
Build Instructions – Stepper Controls

Mounting the PCB to the MDF Board

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

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.

The entire board is secured to the MDF with the ¼" spacers under the 4 corners to place the board so that there is a ¼" gap below.



MDF Rose Engine Lathe 2.0
Build Instructions – Stepper Controls

Wiring – Power Supply (LRS-100-24)

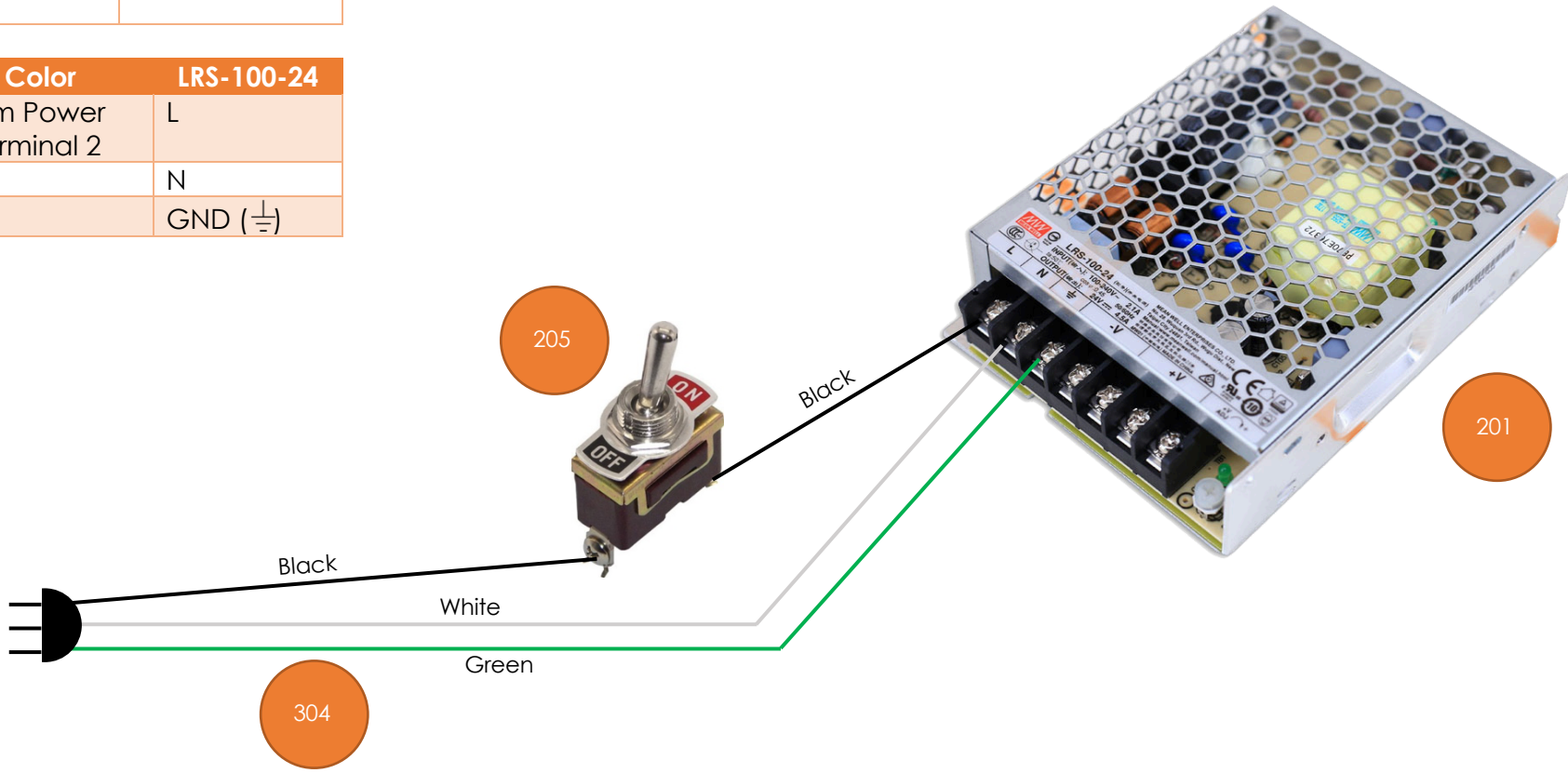
Power Infeed

The power infeed is connected as:

Wire Color	Power Switch
Black Incoming Power	Terminal 1
Black Outgoing Power	Terminal 2

Wire Color	LRS-100-24
Black from Power Switch Terminal 2	L
White	N
Green	GND (⏚)

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



MDF Rose Engine Lathe 2.0
Build Instructions – Stepper Controls

Power Outfeed

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

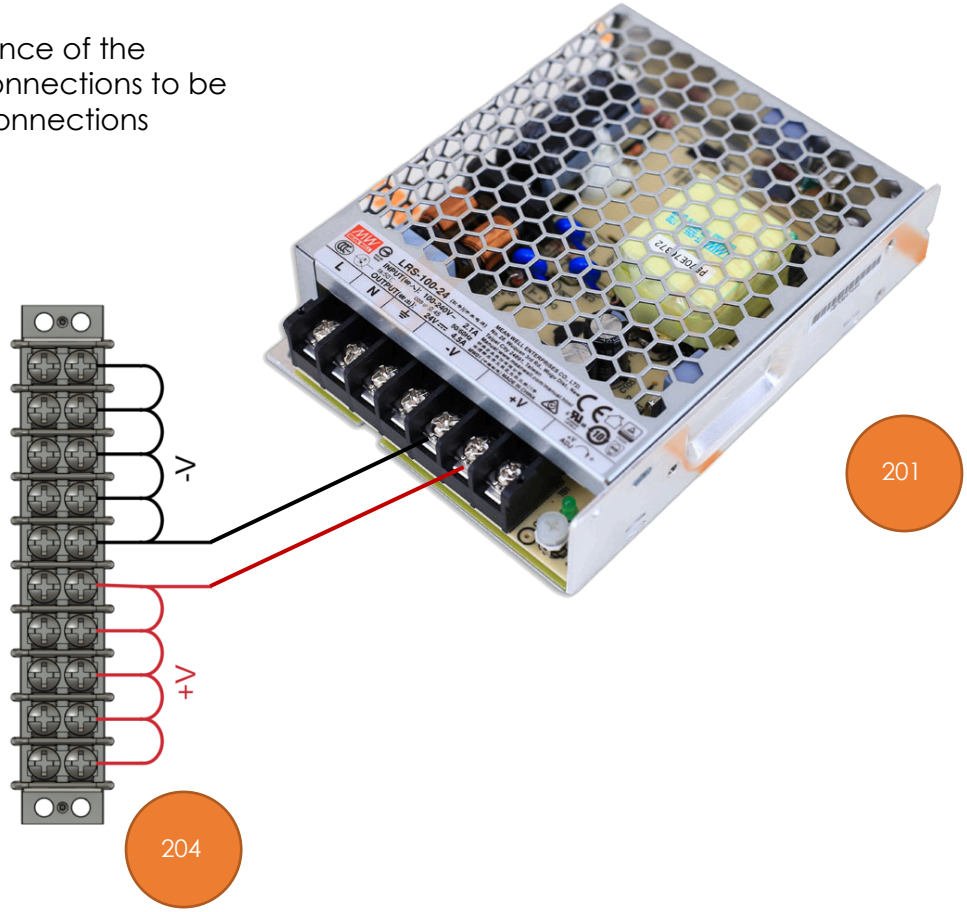
Conductor Type	Stranded or solid copper
Conductor Size	20 or 22 AWG
Cable Size	2 conductors / cable

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.

7. **-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.

8. **+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.



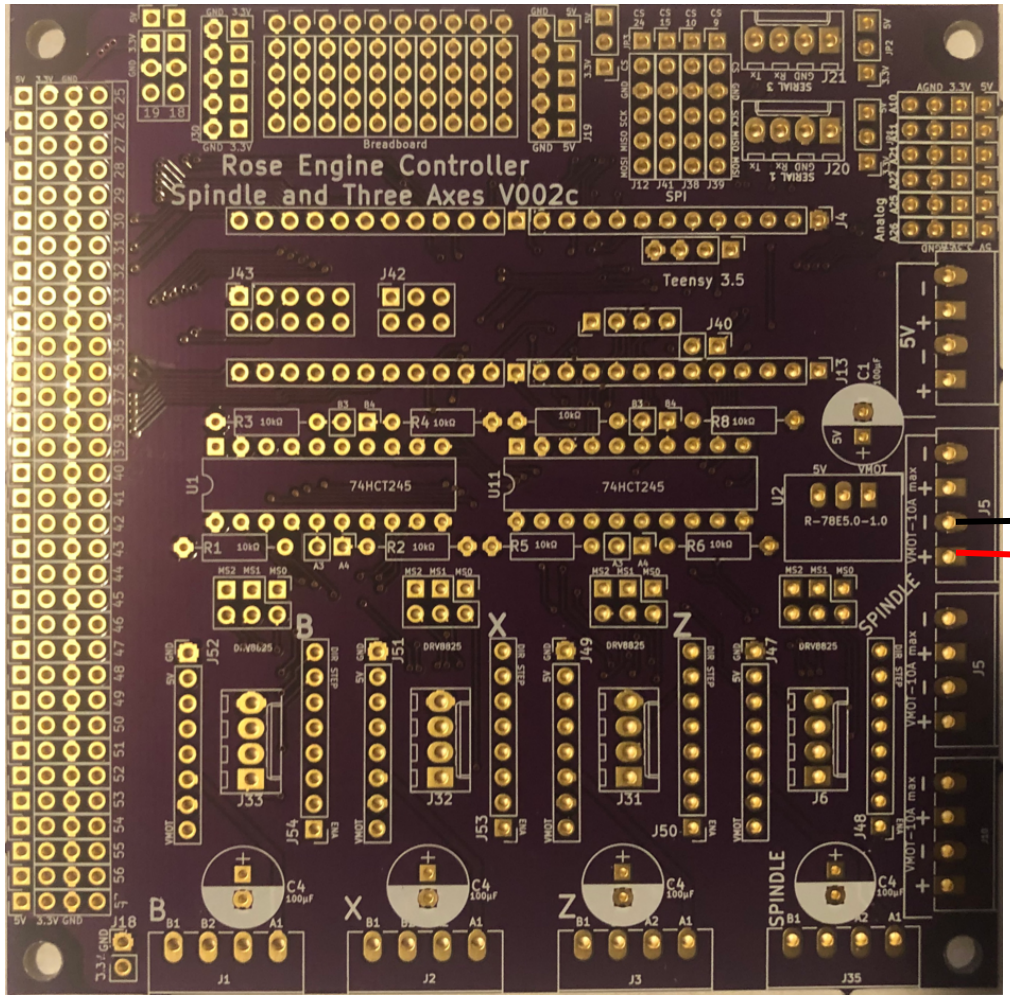
MDF Rose Engine Lathe 2.0

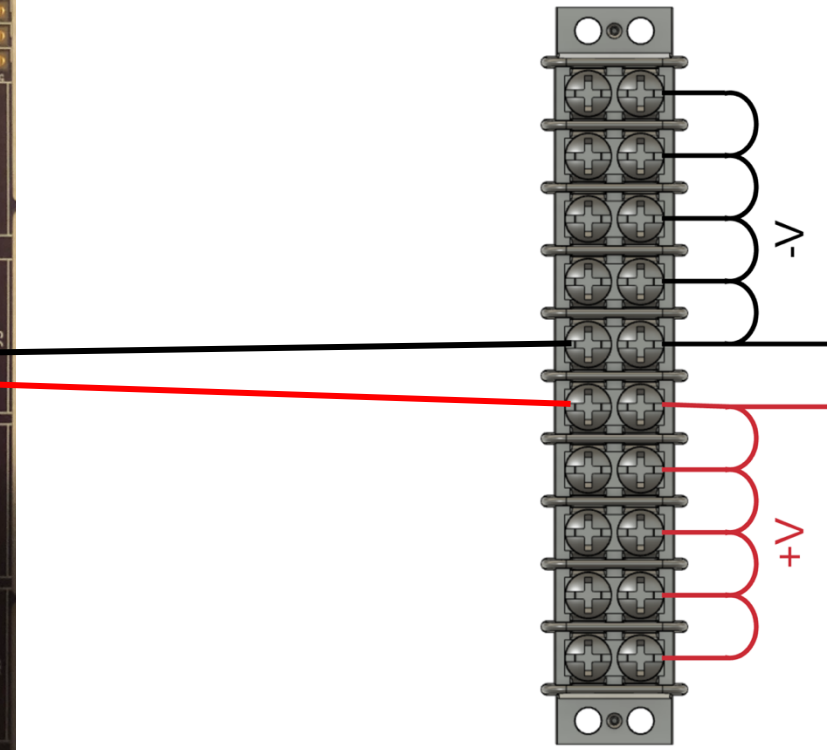
Build Instructions – Stepper Controls

Power Wiring – Printed Circuit Board (PCB)

The PCB is connected to the terminal block for power. The cable from the PCB is already in place from earlier instructions in this document.

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





MDF Rose Engine Lathe 2.0
Build Instructions – Stepper Controls

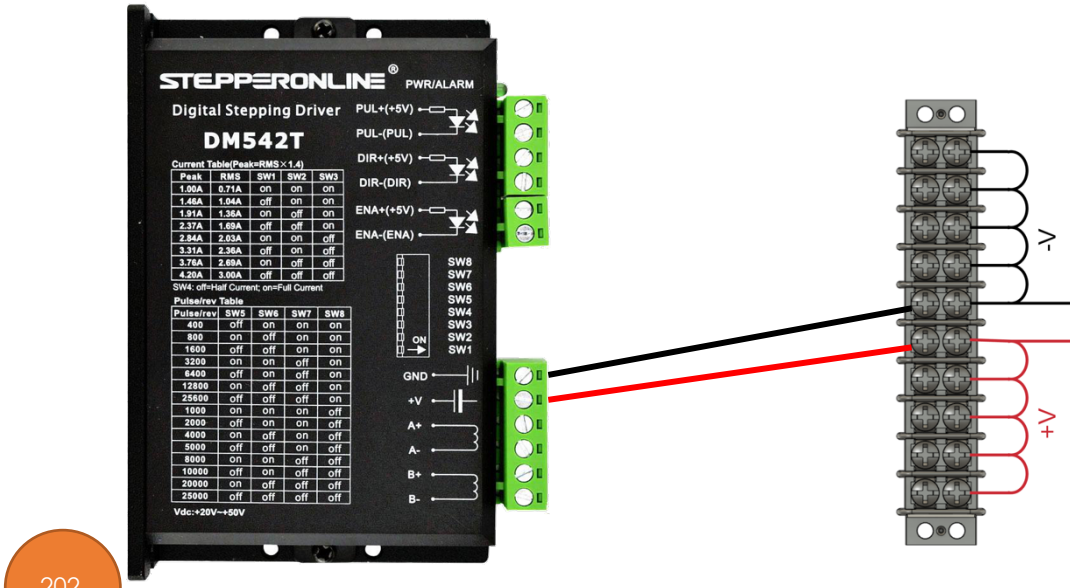
Power Wiring – DM542T Stepper Motor Drivers (4)

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 ⏚

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

303



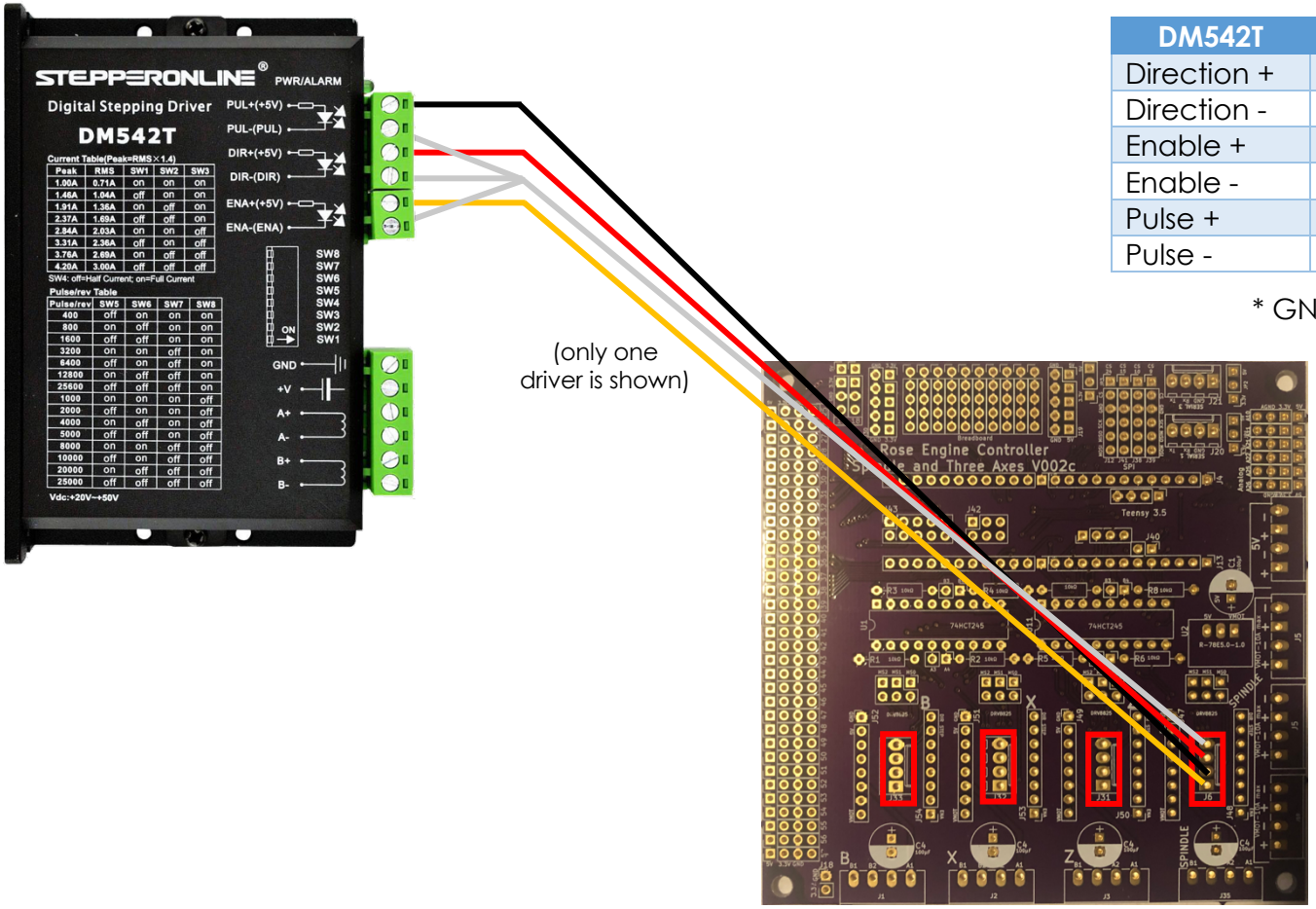
202

MDF Rose Engine Lathe 2.0

Build Instructions – Stepper Controls

Signal Wiring – PCB to Stepper Motor Drivers (4)

Each of the 4 DM542T stepper motor drivers is connected to the PCB via 20 AWG/4 stranded wire. The cable from the PCB is already in place from earlier instructions in this document. The cabling for the Spindle's driver is shown; the other 3 are similar.



DM542T	Wire Color	PCB
Direction +	Red	O DIR
Direction -	White (GND) *	O GND
Enable +	Yellow	☐ ENA
Enable -	White (GND) *	O GND
Pulse +	Black	O STEP/PUL
Pulse -	White (GND) *	O GND

* GND wires tied / bonded together.

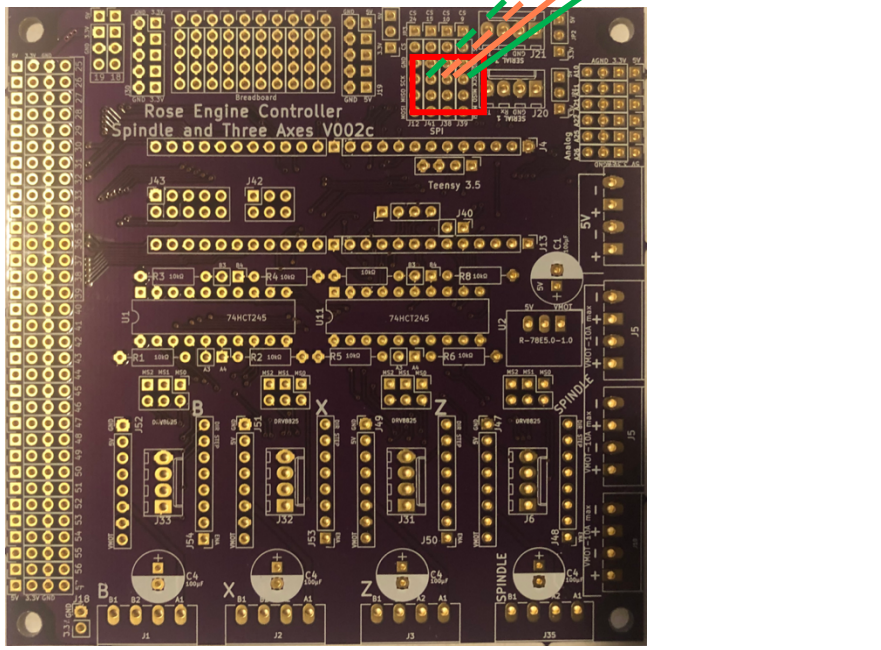
MDF Rose Engine Lathe 2.0

Build Instructions – Stepper Controls

Signal Wiring – PCB to RJ-45 Jack for Nextion Display

The Nextion HMI is connected to the PCB via an RJ-45 connector. The cable from the PCB is already in place from earlier instructions in this document.

PCB	Wire Color	RJ-45 Pin
O Rx	White/Green	1
☐ +5V	Green	2
O Tx	White/Orange	3
	Blue	4
	White/Blue	5
O GND	Orange	6
	White/Brown	7
	Brown	8



Rx
Tx
GND
+5V

203

NOTE:

- Tx on the PCB is connected to Rx on the touch screen.
- Rx on the PCB is connected to Tx on the touch screen

MDF Rose Engine Lathe 2.0

Build Instructions – Stepper Controls

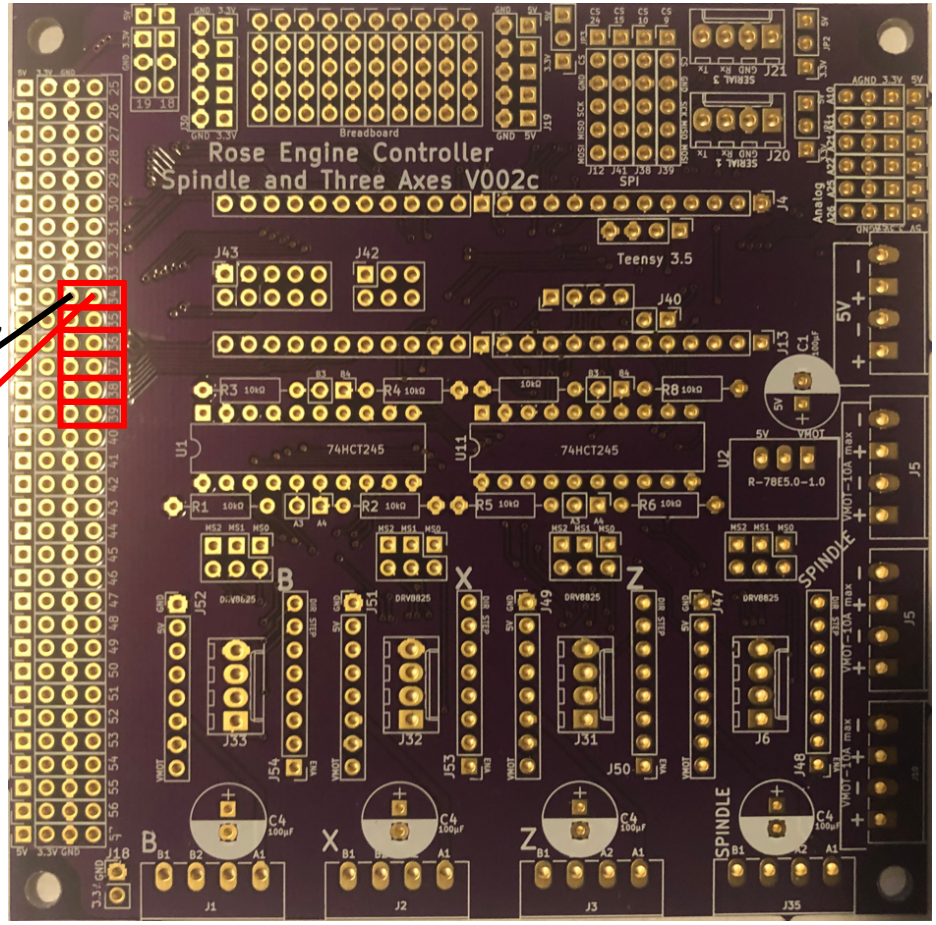
Signal Wiring – PCB to 3.5mm Audio Jack for Limit & Home Switches

The limit switches are connected to the PCB via a 3.5mm (1/8") audio female jack. Pins 34 - 39 on the Teensy are used (one for each limit switch). The cable from the PCB is already in place from earlier instructions in this document.

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

KEY POINT: The sleeve must be connected to ground. (details are on the next page for this)

(only one jack is shown)



NOTES:

1. Most audio jacks that are available are stereo with 3 connectors. Only 2 are needed, so the 3rd one will go unused. Typically, pins 1 and 2 should be used, and 3 should be left unconnected. But check based on the jack you are using.
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.

MDF Rose Engine Lathe 2.0

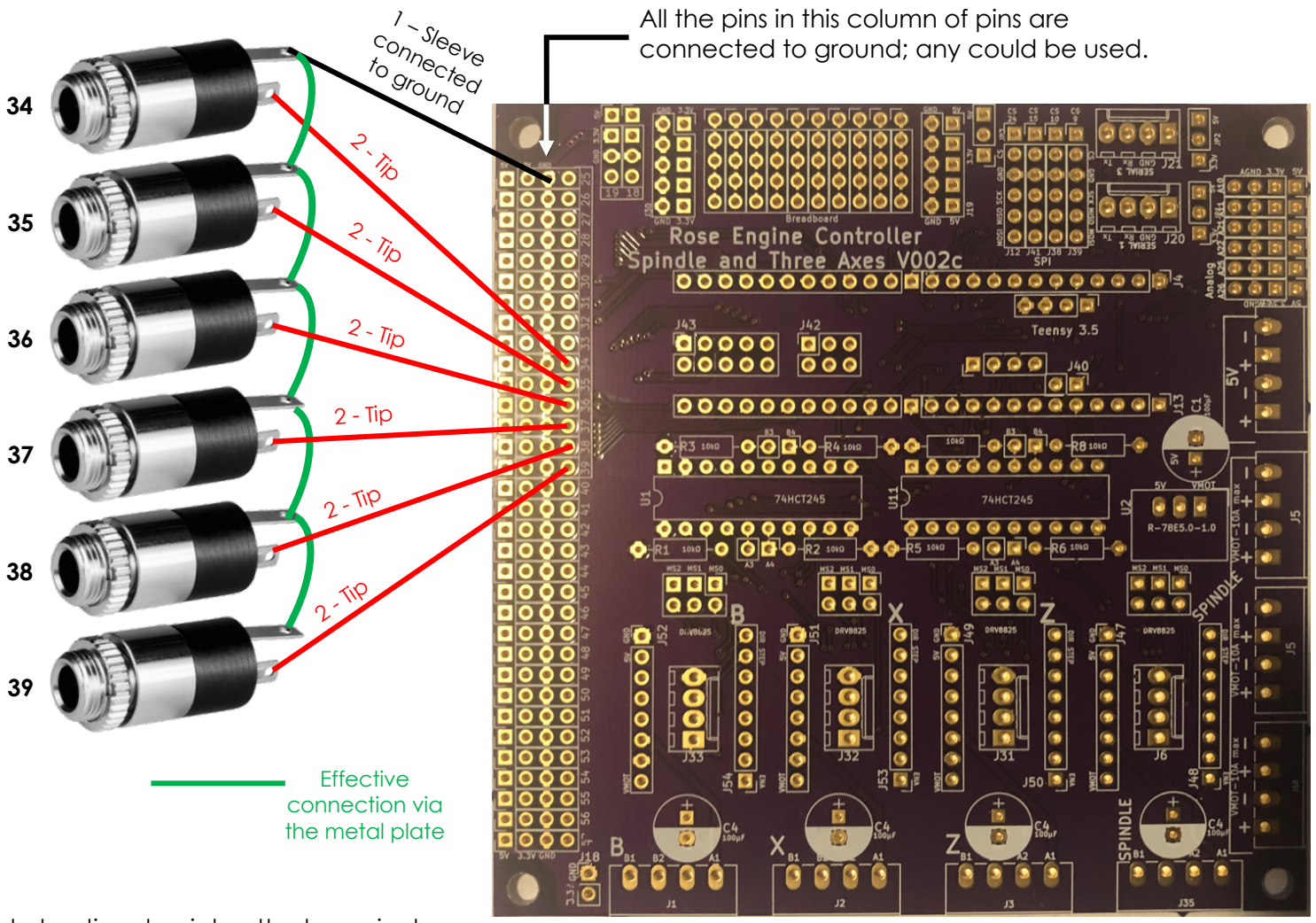
Build Instructions – Stepper Controls

Troubleshooting

The sleeves of the jacks are all effectively connected together as they are all attached to the same metal plate.

A single ground connection could be made, and indeed this may make diagnostics easier.

If any pin # on the PCB is connected to the sleeve on the plug, you will be shorting that one to ground and no stepper motor movement will happen. Everything will seem to work, but the stepper motors won't start running.



Recommended troubleshooting step is to attach one jack at a time, and ensure it works as expected.

MDF Rose Engine Lathe 2.0

Build Instructions – Stepper Controls

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

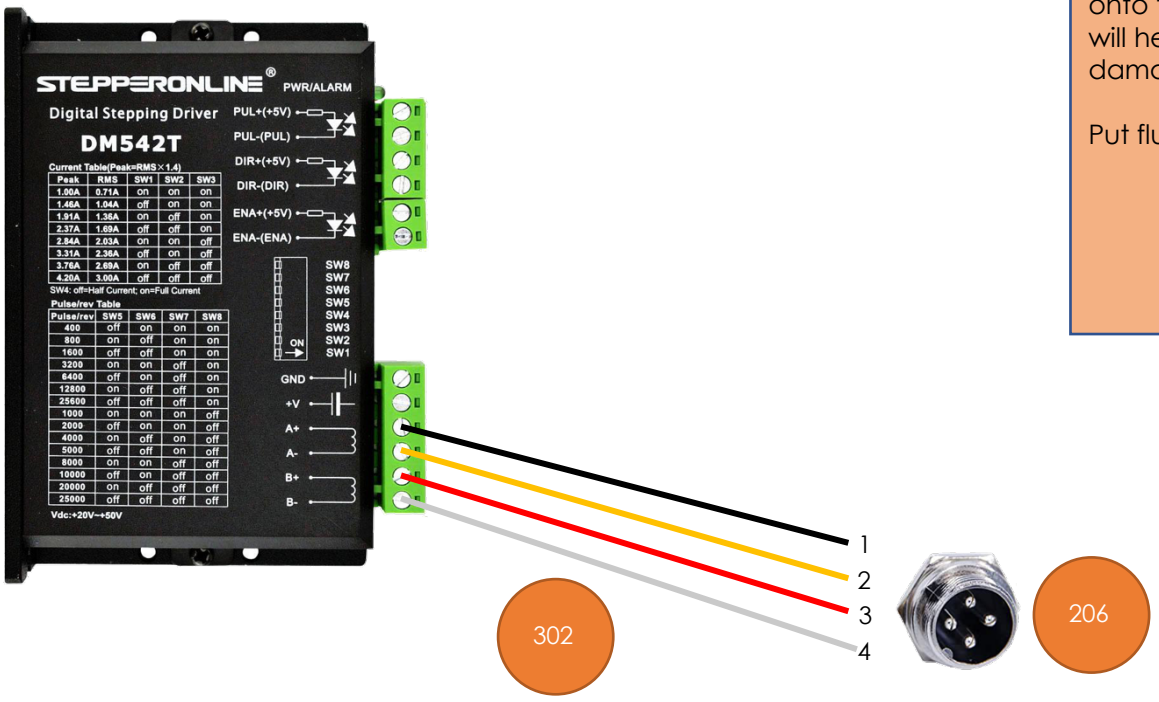
Each of the 4 stepper motors is connected to the stepper motor drivers via GX-16/4 Jacks.

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"

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.

Put flux here

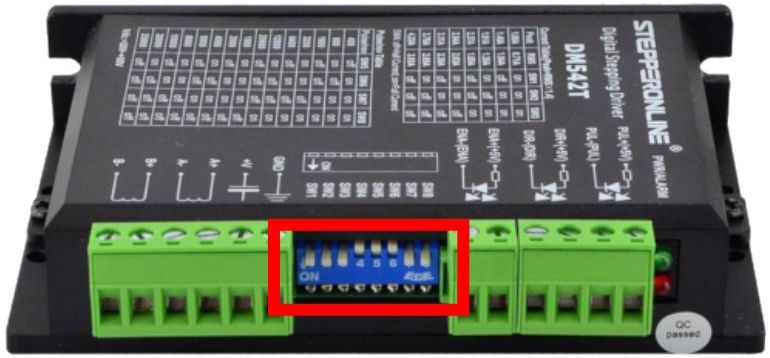


MDF Rose Engine Lathe 2.0
Build Instructions – Stepper Controls

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
	Half Current	4	OFF
Pulses / Rev	6400	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 above.

MDF Rose Engine Lathe 2.0

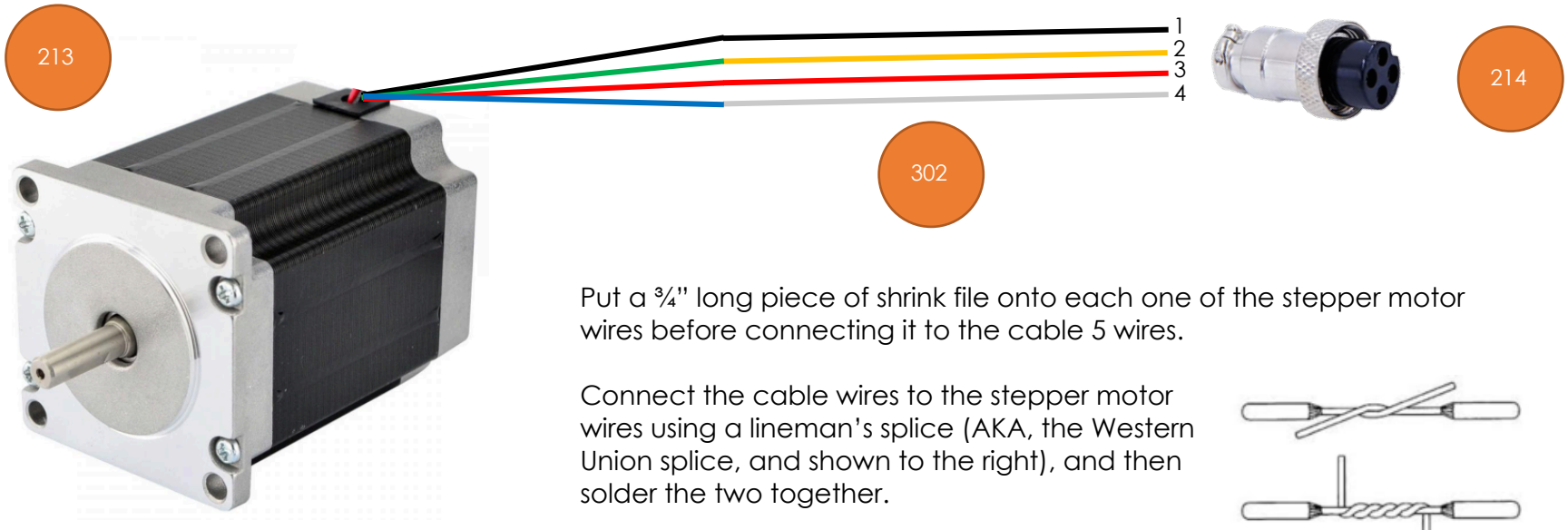
Build Instructions – Stepper Controls

Stepper Motor Connections

Each of the stepper motors is connected to the stepper motor drivers via GX-16/4 plugs. For the spindle drive, a 3-foot cord is recommended. Stepper motor wire colors shown are for the StepperOnline motors. Check that the one you use matches for the connection needed.

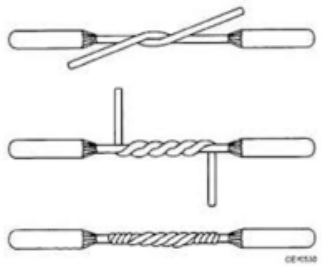
Stepper Motor	Stepper Motor Wire	Cable Wire Color	GX-16/4 Pin
A+	Black	Black	1
A-	Green	Yellow	2
B+	Red	Red	3
B-	Blue	White	4

Conductor Type	Stranded copper
Conductor Size	20 AWG
Cable Size	4 conductors / cable



Put a ¾" long piece of shrink file onto each one of the stepper motor wires before connecting it to the cable 5 wires.

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.

MDF Rose Engine Lathe 2.0

Build Instructions – Stepper Controls

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:

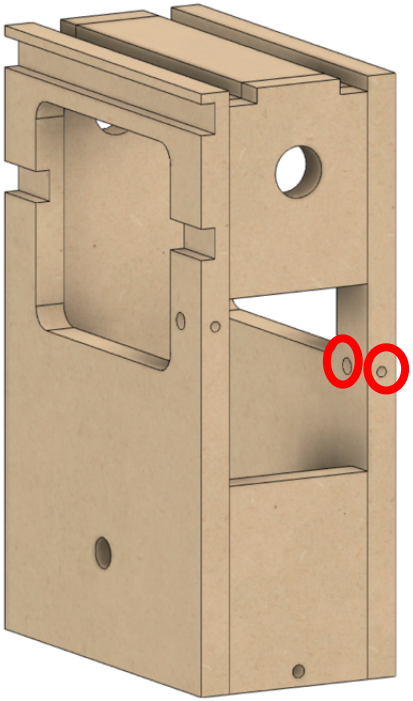
Stepper Motor	Stepper Motor Wire	GX-16/4 Pin
A+	Black	1
A-	Green	2
B+	Red	3
B-	Blue	4

MDF Rose Engine Lathe 2.0

Build Instructions – Stepper Controls

Attaching the Stepper Motor to the Headstock

The stepper motor attaches to the headstock as shown in the picture to the right.



If you purchased the kit we supply, the holes on the left and right are already set properly. If you built it yourself, you will now need to drill the holes for the screws on the right. As noted in the case building instructions, these need to be set based on the alignment of the bracket.

502

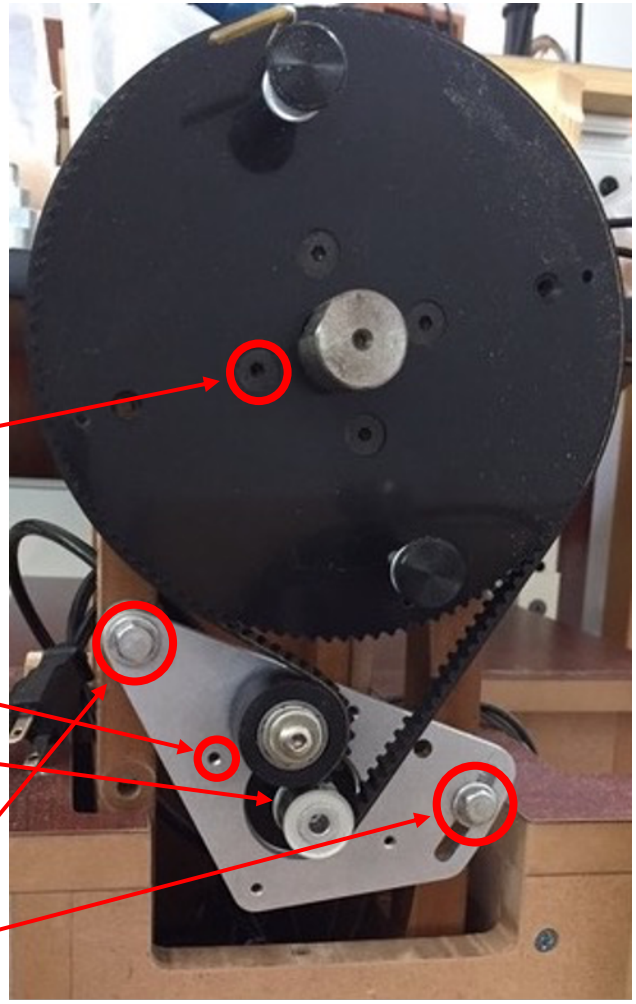
Attach the spindle pulley to the spindle flange. There are 4 screws for this. One is indicated here.

504

Attach the stepper motor to the bracket using 4 screws. One is indicated here.

503

Secure the 12-tooth drive pulley to the stepper motor's spindle.



Attach the bracket to the headstock on both sides. There are two screws and two spacers (they look like thick washers). The spacers are installed between the bracket and the headstock. They are held onto the headstock using barrel nuts. Do not tighten them just yet.

MDF Rose Engine Lathe 2.0

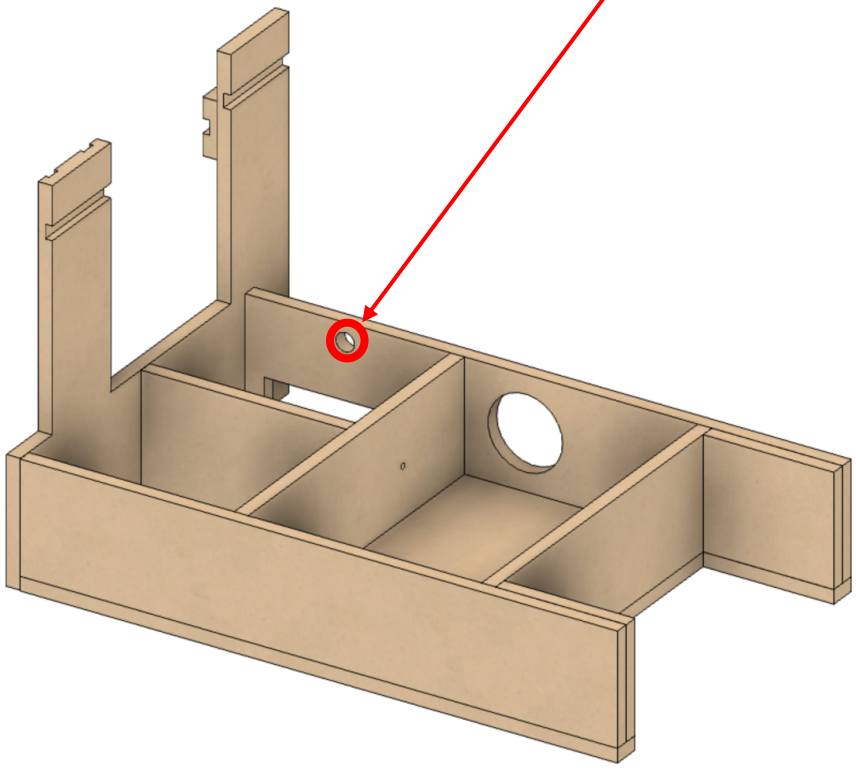
Build Instructions – Stepper Controls

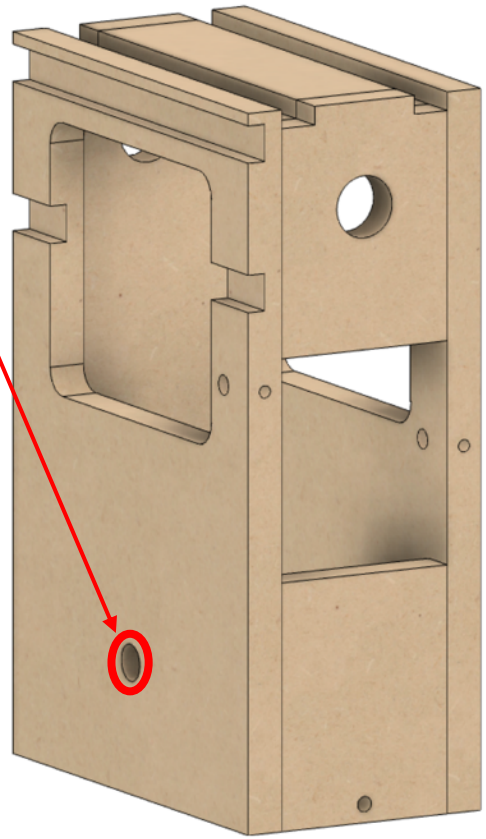
NOTE: The picture on the right is of the assembly on the original MDF rose engine lathe. On version 2.0, there is no need for the cutout in the base to accommodate the bracket.

Install the timing belt (item #501).

Snug the bracket so that the timing belt is tight enough that it won't slip, but not so tight that it stretches. Once it is set, tighten the two bolts holding the bracket to the headstock. They need to be tight enough to not slip, but don't over tighten them as that will cause the barrel nuts to pull thru the MDF.

The stepper motor's cable needs to be fed thru the hole in the back of the headstock, and continue out of the lathe thru the hole in the back of the bed.





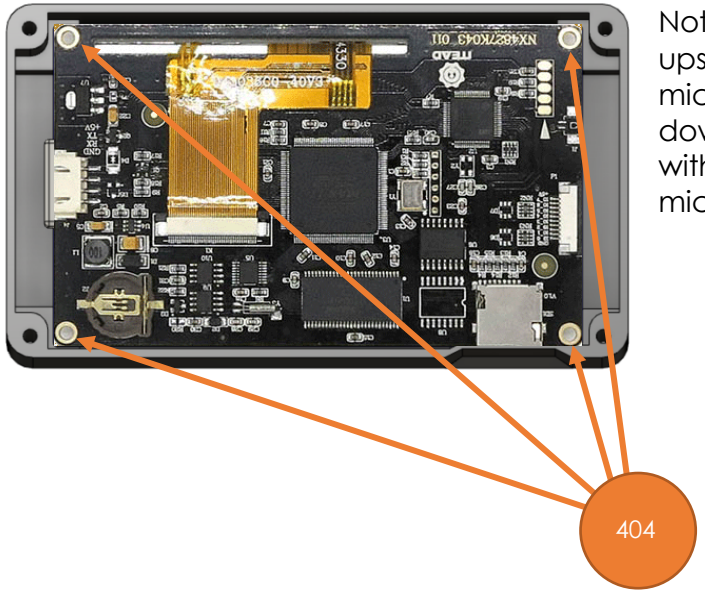
MDF Rose Engine Lathe 2.0
Build Instructions – Stepper Controls

Assembly of the Nextion HMI Box

Attach Nextion Display to the Bezel

One hole is printed into the back side of the bezel for attaching the Nextion HMI (circled in red to the right). That one needs to be enlarged using a #39 drill to a depth of 1/8".

Attach one corner of the Nextion HMI 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.)

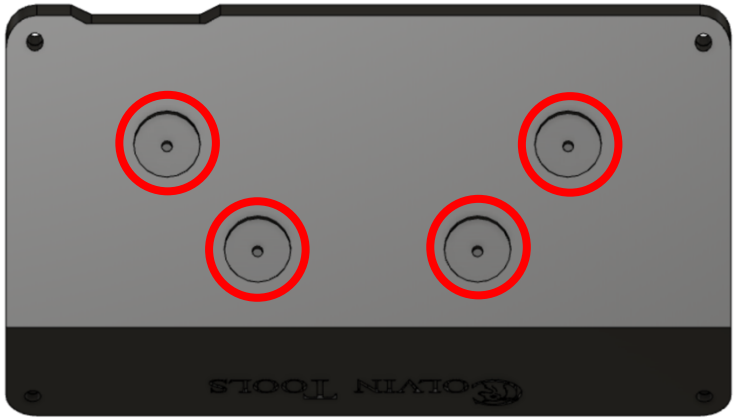
MDF Rose Engine Lathe 2.0
Build Instructions – Stepper Controls

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.

405 409



Insert the Heat-Set Inserts

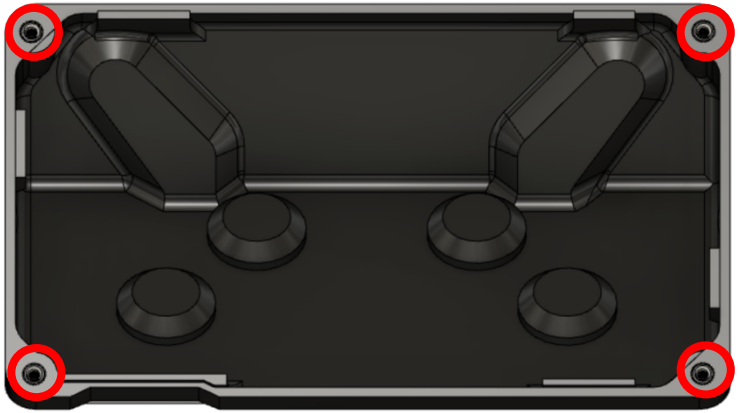
There are two options here:

402

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).

   If you plan to disassemble the box and reassemble it quite a bit, this is probably the way to go. Otherwise, take option #2 (it is much easier.

2. Do nothing at this point, and attach the top using thread forming screws (#410)



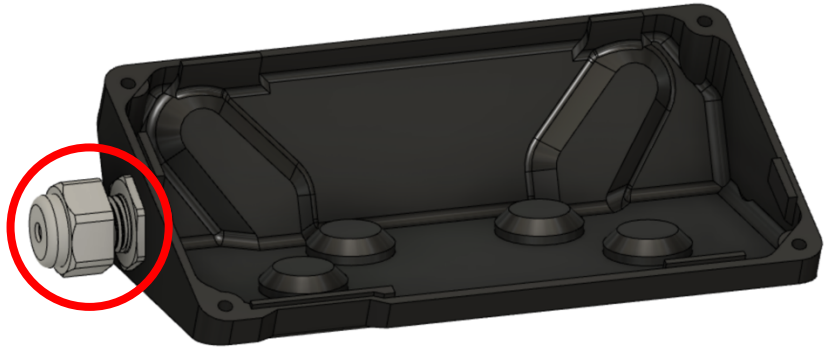
MDF Rose Engine Lathe 2.0
Build Instructions – Stepper Controls

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 whole with a ½" bit to ease the installation.

212



MDF Rose Engine Lathe 2.0

Build Instructions – Stepper Controls

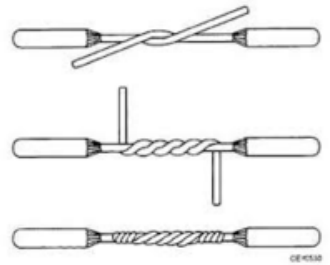
Signal Wiring – PCB to RJ-45 Jack for Nextion Display

The Nextion HMI is connected to the connection box via an RJ-45 connector. Using piece of CAT 5 (or greater) wire, 4 feet long, make the connections to the HMI's connector (supplied by the vendor) as shown to the right.

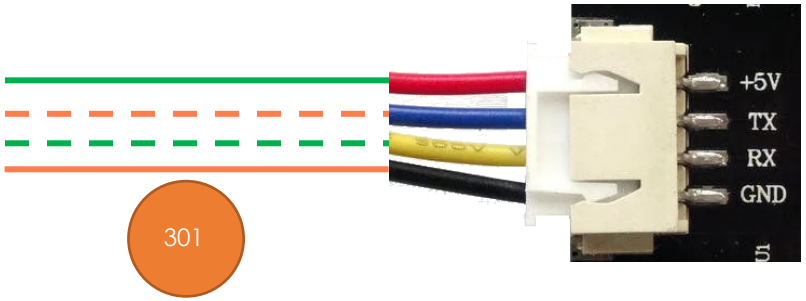
Nextion Connection	Nextion Wire Color		CAT 5 Wire Color	RJ-45 Pin
RX	Yellow		White/Green	1
+5V	Red		Green	2
TX	Blue		White/Orange	3
			Blue	4
			White/Blue	5
GND	Black		Orange	6
			White/Brown	7
			Brown	8

Put a ¾" 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.

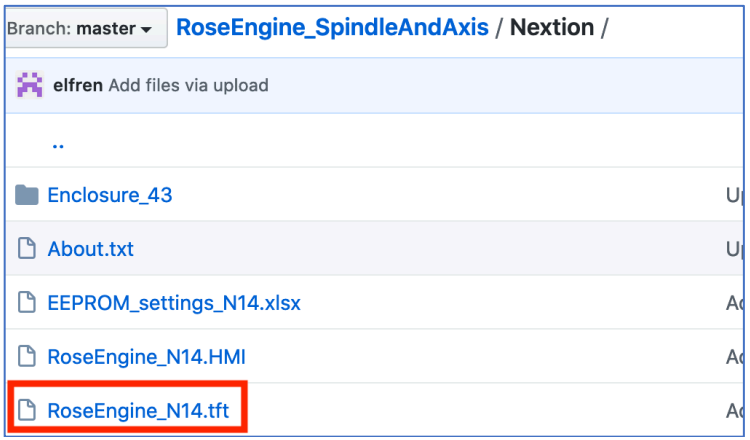


MDF Rose Engine Lathe 2.0
Build Instructions – Stepper Controls

System Setup and Program Loading

Step 1 – Get a copy of the Teensy program file
Download **4Rose.hex** to your computer.

Step 2 – Get a copy of the Nextion configuration file
Download **RoseEngine_14.tft** and put it in the root folder of a microSD card.



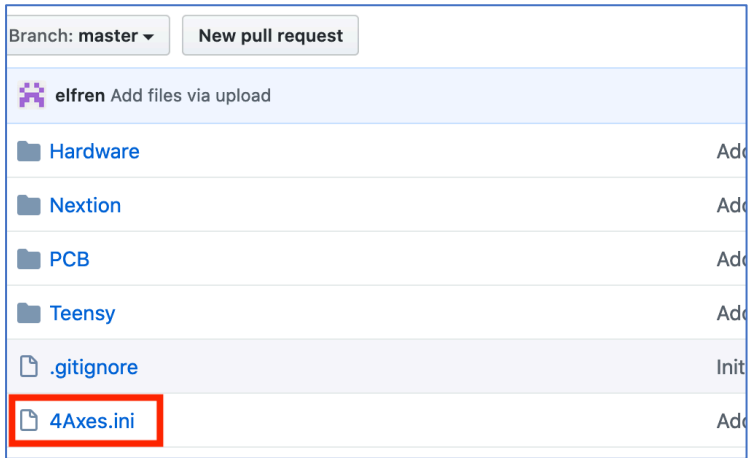
Notes:

1. You can only have one file on this card which is a .TFT file. The upgrade will not work if there is a 2d one.

2. You need to check for hidden files on the microSD card. I found that hard to do on macOS (which created a hidden TFT file) and had to do this on a Raspberry Pi.

MDF Rose Engine Lathe 2.0
Build Instructions – Stepper Controls

Step 3 – Get a copy of the 4Axes.ini settings file
Download **4Axes.ini** and put it in the root of a second microSD card.



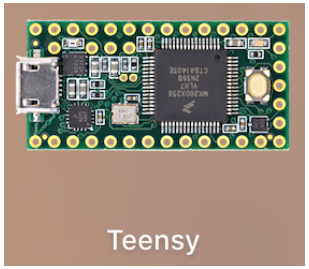
Step 4 - Upgrade the Teensy

Step 4a
Connect the computer to the Teensy.

- The cable end connected to the Teensy uses a MicroUSB connector.
- The Teensy's jack is noted in the picture to the right.

Notes:
Be sure you have a good MicroUSB cable. Some are only used for charging a device (and they are usually longer). These will often not work.

Step 4b
On the Computer, start the **Teensy Loader**. The icon looks like the one to the right.

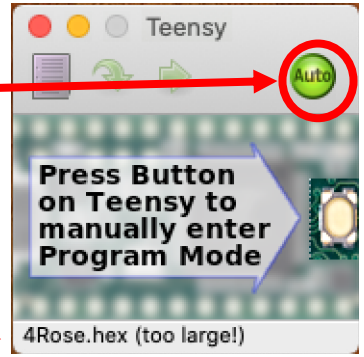


Note:
If you don't have the **Teensy Loader**, you can get it from https://www.pjrc.com/teensy/loader.html.

MDF Rose Engine Lathe 2.0
Build Instructions – Stepper Controls

Step 4c
Be sure the system shows that the Teensy is connected. This is evident when the Auto button is illuminated green. As noted in step 4a above, if your USB cable is bad, this won't light.

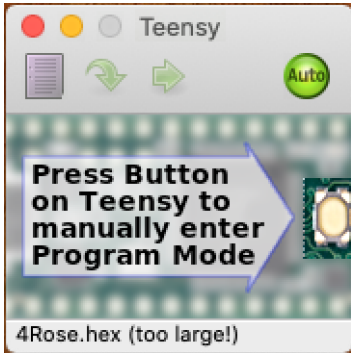
The default for the CPU selected won't handle the whole 4Rose.hex file, so if you try to open it, you will get the message as shown here.



Step 4d
Press the button on the Teensy to load the get the Teensy loader. This will enable the Teensy loader to recognize which CPU you are using and allow the larger program to be loaded.

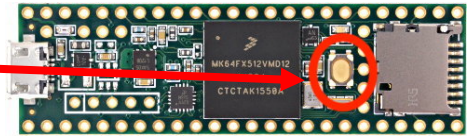
Step 4e
On the Computer, using the **Teensy Loader**, open **4Rose.hex**.

Once this is loaded, the bottom message will change to reflect the file size (this picture was not updated).



Step 4f
Press the button on the Teensy to load the program file.

Disconnect the computer from the Teensy, and then reboot the Teensy.



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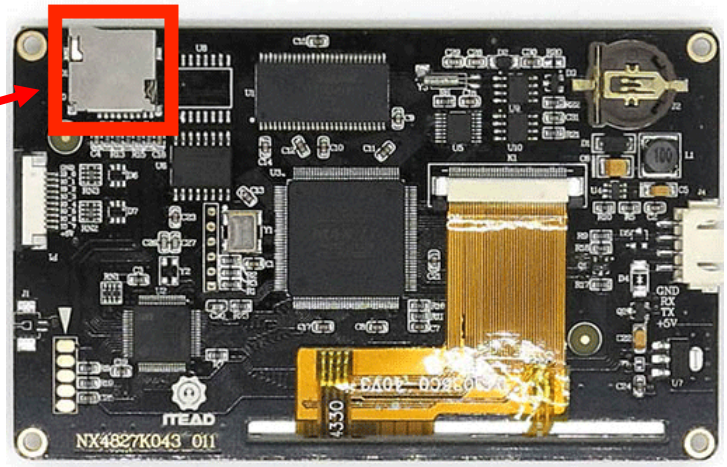
Step 5 – Upgrade the Nextion

Secure the microSD card which has the Nextion configuration file (from step 2).



Put this microSD card into the Nextion's microSD card slot.

Reboot the Teensy again.

If this works as expected, it will read

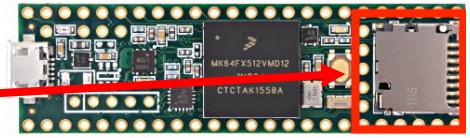
> Check Data … 100%
> Updated Successed!

(guess that is a bad translation from Chinese).

After that message appear, remove the microSD card from the Nextion, and reboot the Teensy again.

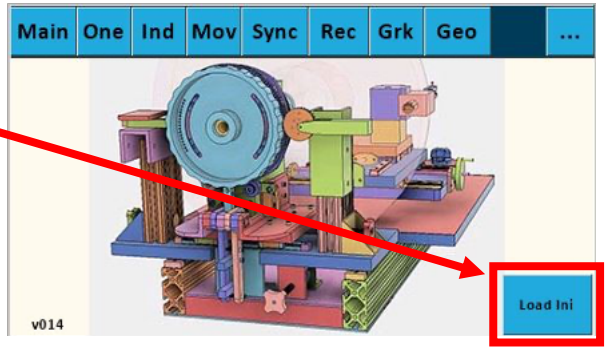
Step 6 - Load the .ini file

Secure the microSD card which has the **4Axes.ini** settings file (from step 3).



Put this microSD card into the Teensy's microSD card slot.

Start the system and click the **Load ini** button on the Nextion screen.



The Load ini button will turn green, and then it will take off.

Once completed, a message will appear saying

> Done – Restart may be needed.

Reboot the system one last time.

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Step 7 – Verify the Settings

It's a good practice to verify all of the settings once you've completed the steps.

1. Touch the Config button on each page and verify the Teensy column is populated with the same numbers as the Nextion column. Repeat for each axis on each page.
2. Next verify the Preferences are correct for the Spindle, Axes, Limits, and Returns.
3. Select the Main page, then the '...' (Preferences) page. Select the More page. Touch EEPROM. Repeat for each page and axis on the page. This will show all of the settings for the selected page.

A copy of the settings file (4Axes.ini) is on the following pages.

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Finishing It Up

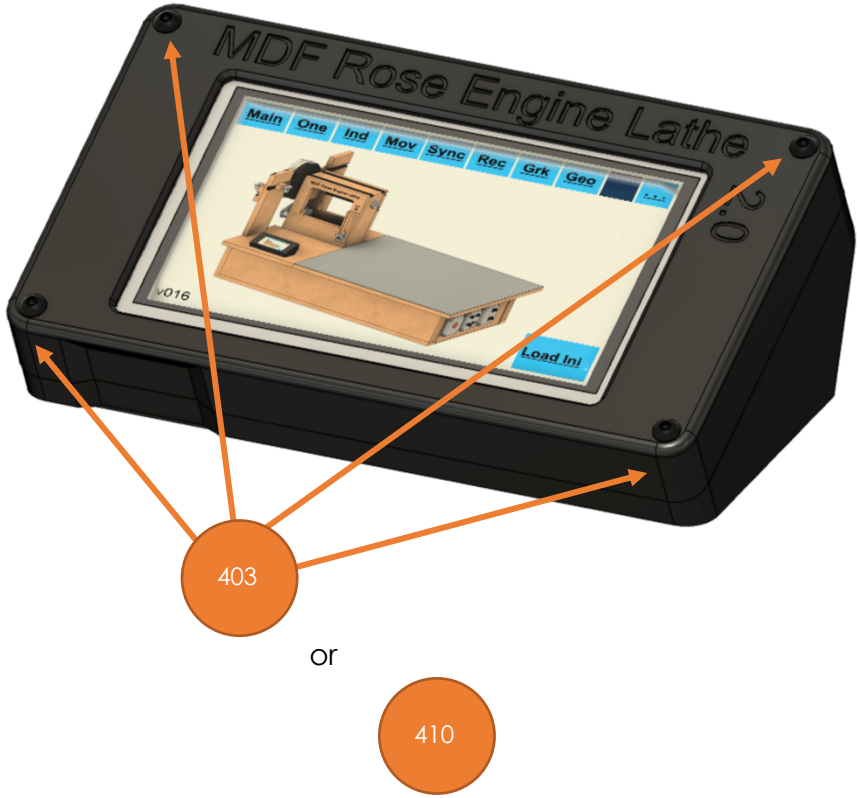
Before screwing the bezel to the base, check to be sure everything works. To do that, you will need to use the instructions in the next section to load the programs into all the pieces.

If it works, screw the two pieces together.

If you took the option to use the heat set inserts back on pg. 48, then attach the lid using four #4-40, ¾" 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.



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4Axes.ini Config File Settings

```
;===================================
[Setup]
;===================================
        BoardType=4
        Microsteps_Spindle=32
        StepsPer360_Spindle=200
        GearRatio_Spindle=9
        Polarity_Spindle=1

;Z Axis
        Microsteps_Z=32
        StepsPer360_Z=200
        DistancePer360_Z=.02
        Polarity_Z=1

;X Axis
        Microsteps_X=32
        StepsPer360_X=200
        DistancePer360_X=.02
        Polarity_X=1

;B Axis
        Microsteps_B=32
        StepsPer360_B=200
        GearRatio_B=150
        Polarity_B=1
        DistancePer360_B=1.02
        RadialOrLineal=0
        BRadius=5
```

```
;===================================
[Limits]
;===================================
;Limit Switches
        Min_Z=34
        Max_Z=35
        Min_X=36
        Max_X=37
        Min_B=38
        Max_B=39

;===================================
[Returns]
;===================================
;Return
        MaxSpeed_Spindle=15011
        Accel_Spindle=15012

        MaxSpeed_Axis_Z=15013
        Accel_Axis_Z=15014

        MaxSpeed_Axis_X=15015
        Accel_Axis_X=15016

        MaxSpeed_Axis_B=15017
        Accel_Axis_B=15018
```

```
;===================================
[Main]
;===================================
;Axis Ids:
;-----------------
;Z=0
;X=1
;B=2
;Spindle=3

;-----------------
        AxisId=0
;Spindle
        MaxSpeed_Spindle=15000
        Accel_Spindle=15001
        SpeedPercentage_Spindle=30

;Z Axis
        MaxSpeed_Z=4001
        Accel_Z=5002
        SpeedPercentage_Z=53

;X Axis
        MaxSpeed_X=4000
        Accel_X=5005
        SpeedPercentage_X=10

;B Axis
        MaxSpeed_B=5007
        Accel_B=5008
        SpeedPercentage_B=59
```

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```
;===================================
[One]
;===================================
        AxisId=3
;Spindle
        MaxSpeed_Spindle=25060
        Accel_Spindle=20061
        SpeedPercentage_Spindle=61
;Z Axis
        MaxSpeed_Z=5062
        Accel_Z=5063
        SpeedPercentage_Z=64
;X Axis
        MaxSpeed_X=5065
        Accel_X=5066
        SpeedPercentage_X=67
;B Axis
        MaxSpeed_B=5068
        Accel_B=5069
        SpeedPercentage_B=70
```

```
;===================================
[Ind]
;===================================
        IndexId=1
        MaxSpeed_Spindle=5070
        Accel_Spindle=5071
        SpeedPercentage_Spindle=72
;-----------------
;Division:0  Degrees:2
;Fixed:0  File:1
;-----------------
;Index 1
        DivisionsOrDegrees_1=2
        FixedOrFile_1=0
        Size_1=1.875
;Index 2
        DivisionsOrDegrees_2=2
        FixedOrFile_2=0
        Size_2=24.375
;Index 3
        DivisionsOrDegrees_3=2
        FixedOrFile_3=0
        Size_3=90
```

```
;===================================
[Mov]
;===================================
        AxisId=0
;Z Axis
        MaxSpeed_Z=5080
        Accel_Z=5081
        SpeedPercentage_Z=82
        Distance_Z=3

;X Axis
        MaxSpeed_X=5083
        Accel_X=5084
        SpeedPercentage_X=85
        Distance_X=5.75

;B Axis
        MaxSpeed_B=5086
        Accel_B=5087
        SpeedPercentage_B=88
        Distance_B=5.78
```

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```
;===================================
[BE]
;===================================
        AxisId=0
;Spindle
        MaxSpeed_Spindle=5090
        Accel_Spindle=5091
        SpeedPercentage_Spindle=92

;Z Axis
        MaxSpeed_Z=5093
        Accel_Z=5094
        SpeedPercentage_Z=95

;X Axis
        MaxSpeed_X=5096
        Accel_X=5097
        SpeedPercentage_X=98

;B Axis
        MaxSpeed_B=5099
        Accel_B=5100
        SpeedPercentage_B=50
```

```
;===================================
[Sync]
;===================================
        AxisId=0
        HelixType=0
        Revolutions=.3
        Distance=10
;Spindle
        MaxSpeed_Spindle=5040
        Accel_Spindle=5041
        SpeedPercentage_Spindle=42

;Z Axis
        MaxSpeed_Z=5043
        Accel_Z=5044
        SpeedPercentage_Z=45

;X Axis
        MaxSpeed_X=5046
        Accel_X=5047
        SpeedPercentage_X=48

;B Axis
        MaxSpeed_B=5048
        Accel_B=5049
        SpeedPercentage_B=49
```

```
;===================================
[Rec]
;===================================
        AxisId=0
        RadialOrAxial=0
;Spindle
        MaxSpeed_Spindle=5030
        Accel_Spindle=5031
        SpeedPercentage_Spindle=32

;Z Axis
        MaxSpeed_Z=5033
        Accel_Z=5034
        SpeedPercentage_Z=35

;X Axis
        MaxSpeed_X=5036
        Accel_X=5037
        SpeedPercentage_X=38

;B Axis
        MaxSpeed_B=5039
        Accel_B=5040
        SpeedPercentage_B=39

;Radial
        Radial_Waves=5
        Radial_Spindle_Amplitude=20
        Radial_Axis_Distance=5

;Axial
        Axial_Waves=4
        Axial_Spindle_Degrees=25
        Axial_Axis_Amplitude=7
```

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```
;===================================
[Grk]
;===================================
        AxisId=0
        FileOrPattern=0
;Spindle
        MaxSpeed_Spindle=5020
        Accel_Spindle=5021
        SpeedPercentage_Spindle=22

;Z Axis
        MaxSpeed_Z=5023
        Accel_Z=5024
        SpeedPercentage_Z=25

;X Axis
        MaxSpeed_X=5026
        Accel_X=5027
        SpeedPercentage_X=28

;B Axis
        MaxSpeed_B=5028
        Accel_B=5029
        SpeedPercentage_B=29

;Pattern page
        RadialOrAxial_Pattern=0
;4a: 2 4b: 3 3a: 6 3b: 7 2a: 4 2b: 5
        PatternType=4
        Pattern_PatternsPer360=8
        Pattern_PatternCount=1
        Pattern_SegmentLength=1

;File page
        RadialOrAxial_File=0
        File_PatternsPer360=7
        File_PatternCount=1
        File_SegmentLength=1

;Segments: 2  Actual: 3
        File_SegmentsOrActual=2
```

```
;===================================
[Geo]
;===================================
        AxisId=0
        RadialOrAxial=0
        Rose_n=7
        Rose_d=5

;Spindle
        MaxSpeed_Spindle=5010
        Accel_Spindle=5011
        SpeedPercentage_Spindle=12

;Z Axis
        MaxSpeed_Z=5013
        Accel_Z=5014
        SpeedPercentage_Z=15
        RadialAmplitude_Z=2
        AxialAmplitude_Z=2.5

;X Axis
        MaxSpeed_X=5016
        Accel_X=5017
        SpeedPercentage_X=18
        RadialAmplitude_X=2
        AxialAmplitude_X=2.5

;B Axis
        MaxSpeed_B=5018
        Accel_B=5019
        SpeedPercentage_B=19
        RadialAmplitude_B=3
        AxialAmplitude_B=3.5
```

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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.

	Configuration			
Component	**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 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.

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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 will be easier to implement over the long term.

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Document Version History

Ver	Date	Comment
1.2	15 Dec 20	• Added parts to the bill of materials • Added details on the installation of the 3.5mm phono jacks.
1.1	10 Dec 20	• Added details for optional configurations. • Added information for attaching the stepper motor to the headstock
1.0.2	07 Dec 20	• Updated p/n for item #204; also updated p/n & qty for item #102. • Added note on soldering on 3.5mm jacks first.
1.0.1	05 Dec 20	• Updated commentary about stepper motor needed. • Added information about stepper motor mount, pulleys, and belt. • Updated drawing dimensions.
1.0	01 Dec 20	Initial document

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