

# DQMusicBox - music player for people with dementia

## How to build one - it's easy

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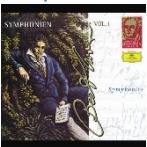
My Dad could not operate normal music players. But he could operate this music player because it operates like a familiar two-knob radio. My son & I were inspired to design this by the documentary [Alive Inside](#) which shows the profound joy felt by some people with dementia when listening to their favorite music.

It's easier than you think to make one. Everything I did (e.g. software, wood case design) is open source. This document contains all the information you need. You can order the parts online. No soldering required.

<b>Parts cost</b>	~\$95 + tax + shipping
<b>Music cost</b>	Minimal as you should use the recipient's existing music collection
<b>Build time</b>	About four hours, once you have the parts & music
<b>Parts source</b>	All parts can be mail ordered, links below
<b>Soldering?</b>	No
<b>Command-line Linux?</b>	No
<b>Laser cutter needed?</b>	No, you can mail order the pre-cut pieces for the wood case
<b>With a friend?</b>	Good idea, especially if your friend has the basic tools required
<b>Beverage?</b>	I recommend a hoppy IPA while you are assembling



# 1 Preview of the steps

1) Order parts  	2) Assemble recipient's favorite music 	3) Copy software to micro SD card 
4) Receive the parts 	5) Glue 	6) Wire the knobs 
7) Wire everything else 	8) Enjoy 	

## 2 No warranty

USE THESE DQMUSICBOX PLANS AND SYSTEM AT YOUR OWN RISK. THE DQMUSICBOX PLANS ARE PROVIDED AS IS WITHOUT WARRANTY OF ANY KIND EITHER EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. THE ENTIRE RISK AS TO THE QUALITY AND PERFORMANCE OF THE PLANS AND SYSTEM IS WITH YOU. SHOULD THE PLANS OR SYSTEM PROVE DEFECTIVE, YOU ASSUME THE COST OF ALL NECESSARY SERVICING, REPAIR OR CORRECTION. IN NO EVENT WILL ANY PARTY BE LIABLE TO YOU FOR DAMAGES, INCLUDING ANY GENERAL, SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF THE USE OR INABILITY TO USE THE PLANS OR SYSTEM.

## 3 Acknowledgements

People were very generous with their time, and I really enjoyed the experience. This is certainly an incomplete list: Alex & Mike & others at [Ada's](#), the super smart staff at [Metrix](#), neighbor Randy, [Stephen Christopher Phillips](#), [Bob Rathbone](#), [Stephen Rusk](#), [Graham Hill](#), support at [Ponoko](#), and my son.

## 4 What DQMusicBox does

### 4.1 For the person with dementia

Name	Description & implementation
Start song	Turning either of the knobs will start music playing.
Change song	Turn the songs knob.
Change volume	Turn the volume knob.
Pause	Tap the volume knob. Note that this also happens automatically – music pauses if there are no knob events in one hour.

### 4.2 For you

Name	Description & implementation
Shut down	Pull the power plug or long hold (15-30 seconds) on the volume knob.
Reboot	Pull the power plug and re-insert or long hold (15-30 seconds) on the songs knob.
Add/remove music	By adding/removing files on the USB memory stick.

## 5 Things you don't need to do

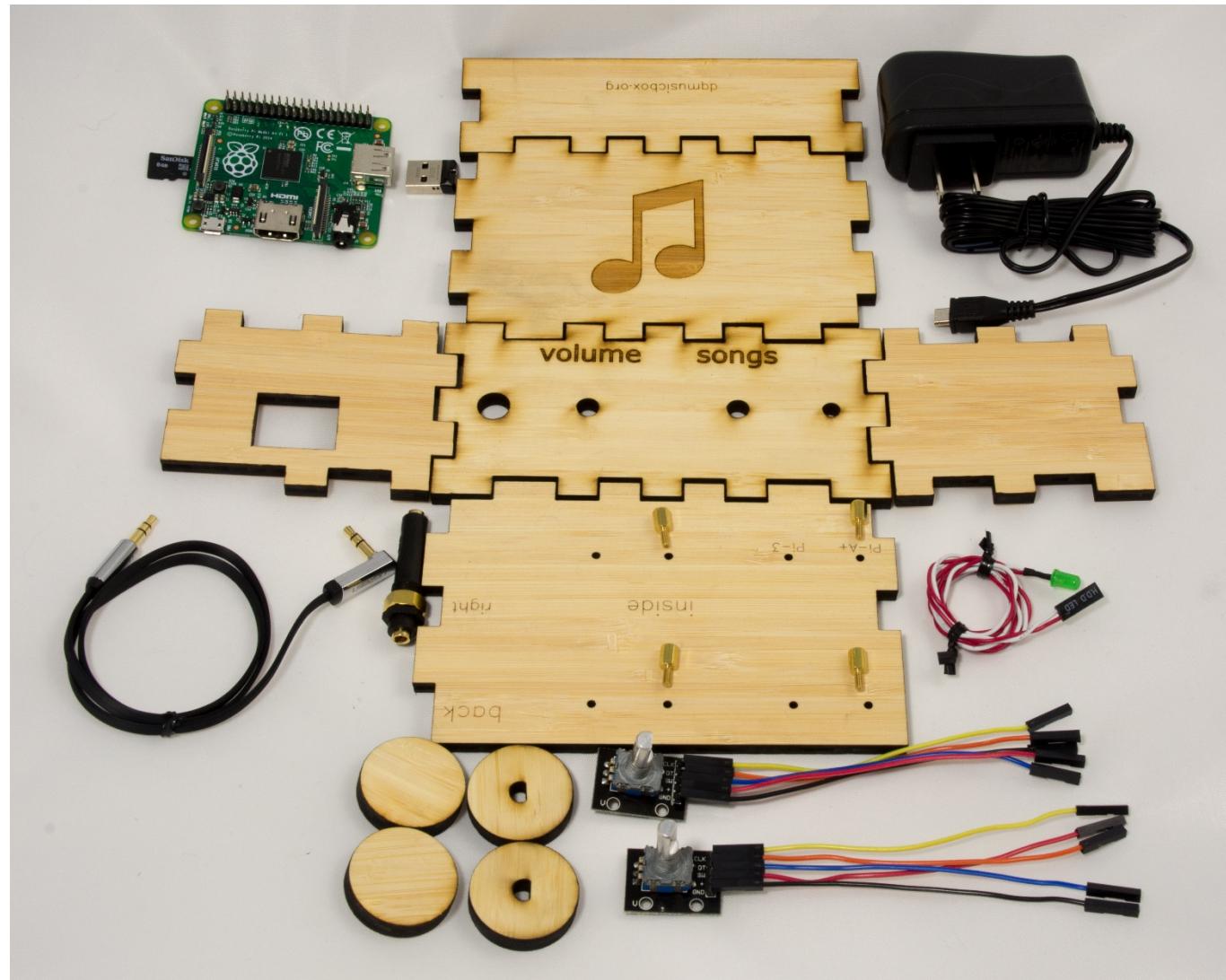
I have done a number of things for you. If you have done other open source electronics projects, you might assume that you have to do the things below. But don't. Unless you want to customize.

<b>Don't connect a monitor and keyboard</b>	There is no need to connect the DQMusicBox to a monitor and keyboard as part of this build process. In fact, the sound system can behave differently if a monitor is connected.
<b>Don't connect to a network</b>	There is no need to connect the DQMusicBox to a network as part of this build process. Nor does the DQMusicBox need to be on a network to operate as a music player. In both cases this is deliberate – want to keep it simple and safe. That said, you can connect it to a network from time to time if you wish.
<b>Don't login to the DQMUSIXBOX</b>	You don't need to. But if you wish to, the username=root password=dietpi i.e. unchanged from the defaults.
<b>Don't go to github</b>	Everything is in the distribution that you will download below. But this is an open source project, so naturally everything is in github if you want to poke around. <a href="https://github.com/rosswesleyporter/dqmusicbox">https://github.com/rosswesleyporter/dqmusicbox</a>
<b>Don't put stain on the bamboo case</b>	The bamboo is quite durable without stain. Also, I don't recommend adding stain because darkening the wood will reduce the legibility of the knob labels.
<b>Don't use a USB audio adapter</b>	The Raspberry Pi that is inside the DQMUSIXBOX has a reputation for OK but not great built-in audio. This project uses a firmware update from the Raspberry Pi foundation that results in really really good audio quality.

## 6 Order the parts

### 6.1 The parts

Here are all of the parts that you will be using:



## 6.2 Create a Ponoko account

Ponoko is a company that laser cuts wood and sends you the precisely cut pieces. You don't need to use Ponoko – you are welcome to take [my case design files](#) to your local maker space and use the laser cutter there. Or buy yourself a laser cutter (if you do, will you be my friend?). In other words, Ponoko is convenient but not necessary. I have no affiliation with them, other than being a happy customer. To create a Ponoko account:

1. Go to <https://www.ponoko.com/>
2. Choose "Get Making"

## 6.3 Order from Ponoko

1. Go to <https://www.ponoko.com/design-your-own/products/dqmuiscbox-case-bamboo-14248>
2. Click on "Add to Personal Factory"
3. Login
4. Check to accept the license, click "Add"
5. The result should be:

The screenshot shows the Ponoko interface for managing 2D materials. At the top, it says "Your 2D materials" and has a flag icon. Below that, there are two items listed:

- dqmuiscbox\_2p1\_bamboo4a.svg**  
Bamboo - Blonde - 3 Ply  
6.7 mm  
P1 - 181.0 mm long x 181.0 mm wide  
Making: \$5.33  
Material: \$5.50  
Total: \$10.83  
With Prime you'll pay just \$9.10 total.  
All orders over \$100 qualify for free shipping.  
Change Remove
- dqmuiscbox\_2p1\_bamboo4b.svg**  
Bamboo - Blonde - 3 Ply  
6.7 mm  
P1 - 181.0 mm long x 181.0 mm wide  
Making: \$12.30  
Material: \$5.50  
Total: \$17.80  
With Prime you'll pay just \$13.80 total.  
All orders over \$100 qualify for free shipping.  
Change Remove

6. Click "Make it"

## 6.4 Order the remaining parts

Item	Supplier	Cost \$US, May 2017	Notes & Alternatives
DQMusicBox bamboo case	Ponoko	\$ 28.63	See instructions above.
<a href="#">Raspberry Pi A+</a>	MCM	\$ 20.00	Or buy from Amazon. You can also use a Raspberry 2 or 3.
<a href="#">Power supply</a>	MCM	\$ 5.99	Any micro USB 2A or better power supply will do.
<a href="#">Female-female jumper wires</a>	MCM	\$ 3.79	<a href="#">Amazon</a>
<a href="#">Panel mount headphone jack</a>	MCM	\$ 2.69	<a href="#">Amazon</a>
<a href="#">Standoff with 6mm screw and 7mm spacer</a>	Amazon	\$ 1.99	<a href="#">Amazon</a>
<a href="#">Micro SD card 8GB</a>	Amazon	\$ 5.99	Any brand name micro SD card that is 8GB or larger will do.
<a href="#">KY-040 rotary encoders (knobs)</a>	Amazon	\$ 8.99	Search for KY-040 on Amazon or your favorite supplier. Look carefully at the product photo -- you need encoders with screw threads.
<a href="#">Indicator LED</a>	Amazon	\$ 4.49	Search for "HDD LED", look for an LED that looks identical.
<a href="#">USB thumb drive 8GB</a>	Amazon	\$ 7.14	While nearly any USB thumb drive will work, I recommend one that is physically tiny so it doesn't protrude much from the case.
<a href="#">Audio cable</a>	Amazon	\$ 4.99	Search "audio cable right angle".
<b>TOTAL</b>		<b>\$ 94.69</b>	Prices will vary. Does not include tax, shipping.

## 6.5 About headphones

Item	Cost \$US, May 2017	Notes and alternatives
The recipient's existing headphone	\$0.00	The best headphones are the headphones that the recipient is already used to.
<a href="#">Panasonic RP-HT21</a>	\$7.74	Acceptable sound. Long cord.
<a href="#">AmazonBasics On-Ear Headphones</a>	\$13.99	Very good sound. Cord is a bit short.
<a href="#">AmazonBasics Over-Ear Headphones</a>	\$19.99	I haven't tried these myself, but the reviews are good.
<a href="#">Sony MDR7506</a>	\$79.99	Amazing sound. My Dad loved the sound. But found the headphones to be a bit frustrating – they tend to fold themselves up. And the cord can get tangled.

## 6.6 Tools & supplies

You probably have some of these tools & supplies. If you don't, you have a spouse or child or friend that does. This project is exactly the sort of thing that a friend would be happy to help you with.

Link to order item	Notes & alternatives
Elmer's wood glue	Any wood glue will do
3/16 <sup>th</sup> wrench or nut driver	Or have really strong fingers
SD card reader/writer	Your computer may have an SD card reader/writer. If not, you probably have a friend that does. Or order a <a href="#">USB SD-card reader</a> for your computer.
Painter's tape	Any tape that comes off easily will do. Painter's tape is great. Regular masking tape is probably fine too. I haven't tried Scotch tape.
Raspberry Pi 3 (optional)	This is completely optional. If you are nerd like me, or you have nerdly friend, see details in the appendix 1.

## 7 Assemble the personalized collection of music

### 7.1 Choosing the music - go for familiar favorites

This is the most important step. The personalized (familiar) music is the fundamental magic. You don't need much music, perhaps 6-10 albums. But only familiar favorites. One of the few benefits of dementia is that you don't remember what you just listened to and thus don't get tired of your favorite albums. In my case, my Mom mailed me my Dad's favorite CDs. It will take two weeks for the parts above to arrive, so you have time to do this well.

### 7.2 Put the music on the USB memory stick

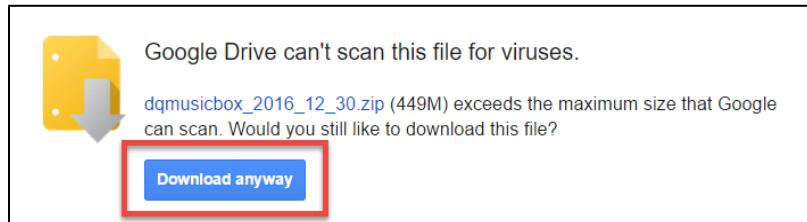
Organize the digitized music into folders on the USB memory stick, one folder per album. MP3, iTunes, and FLAC files are supported i.e. files with extensions .mp3, .m4a, .flac. In the end, you should have a set of folders that looks something like this:

Name	Date modified	Type
A_Beethoven9	10/24/2015 6:25 PM	File folder
B_Eli_Porter_-_Eli_Porter	10/24/2015 6:25 PM	File folder
C_Mozart_-_Overtures	10/24/2015 6:25 PM	File folder
D_Tchaikovsky_-_Concerto for Violin i...	10/24/2015 6:25 PM	File folder
E_Vivaldi_Telemann_Bach_Mercadante...	10/24/2015 6:25 PM	File folder
F_Samuel Barber_-_Barber; Adagio for ...	10/24/2015 6:26 PM	File folder
G_James Galway_-_Serenade	10/24/2015 6:26 PM	File folder
H_Giacomo Puccini_-_Madama Butter...	10/24/2015 6:26 PM	File folder
I_Giacomo Puccini_-_Madama Butterfl...	10/24/2015 6:26 PM	File folder
J_Giacomo Puccini_-_Madama Butter...	10/24/2015 6:26 PM	File folder
K_Leontyne Price_-_Arias	10/24/2015 6:26 PM	File folder

## 8 Prepare the micro-SD memory card

I prepared a disk image for you. It has all the required software. Your job is to download this disk image and then write it to the micro-SD card. The steps:

1. Install [Etcher](#) on your PC or Mac or Linux computer. [Win32 Disk Imager](#) also works.
2. Download the [DQMUSICBOX disk image](#), 449MB.



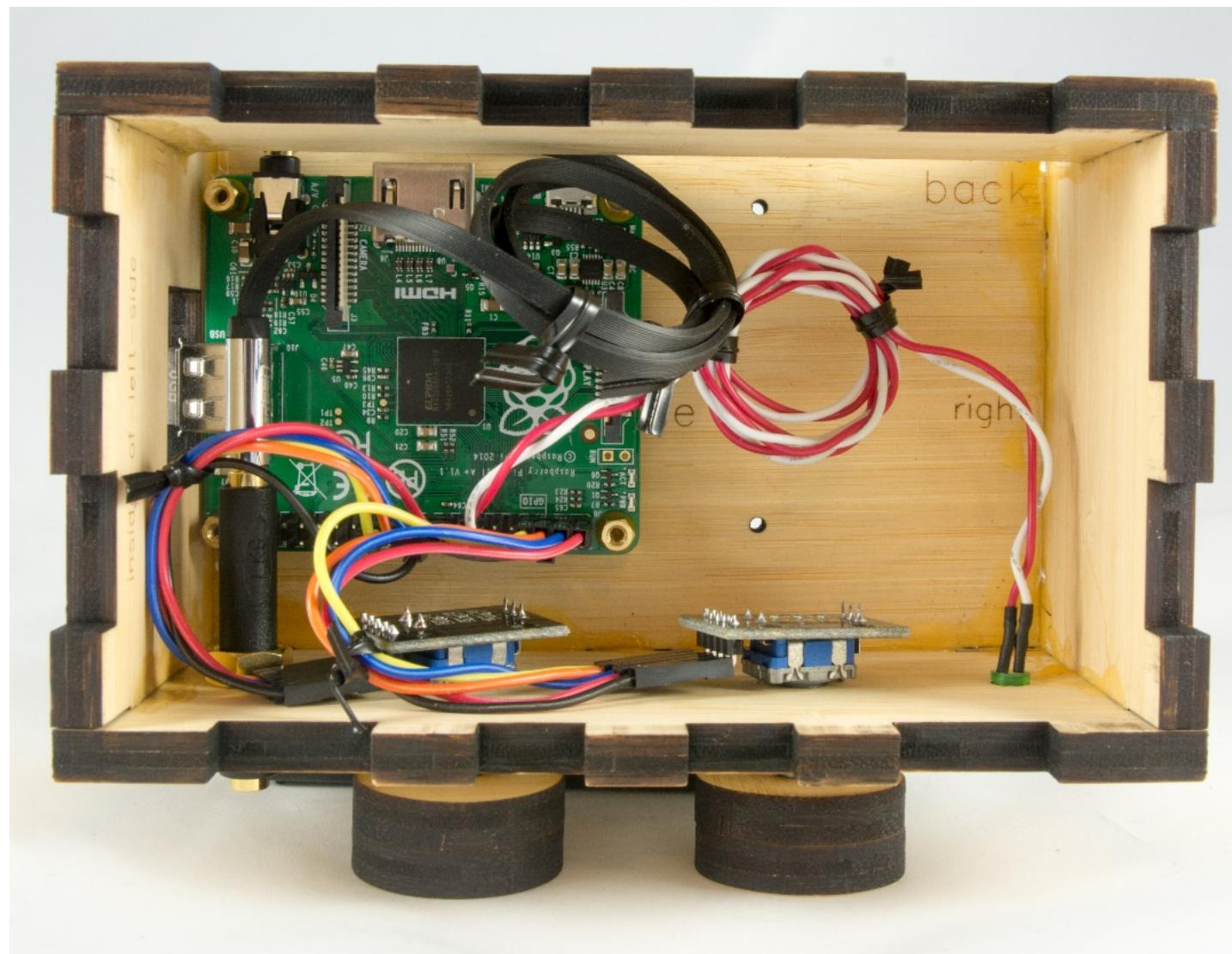
3. Put the micro-SD memory card into the SD card adapter that it came with i.e. put the tiny card into the larger card.
4. Put the SD card adapter into the SD reader/writer in your computer.
5. Start Etcher, instruct it to write the image file to the SD card:



6. Wait for the writing to complete, ~10 minutes. This would be a good time to make a sandwich.
7. If you are a nerd or your friend is a nerd, see the optional step in Appendix 1.

## 9 Make it

Below is finished product that you will create in the steps further below.



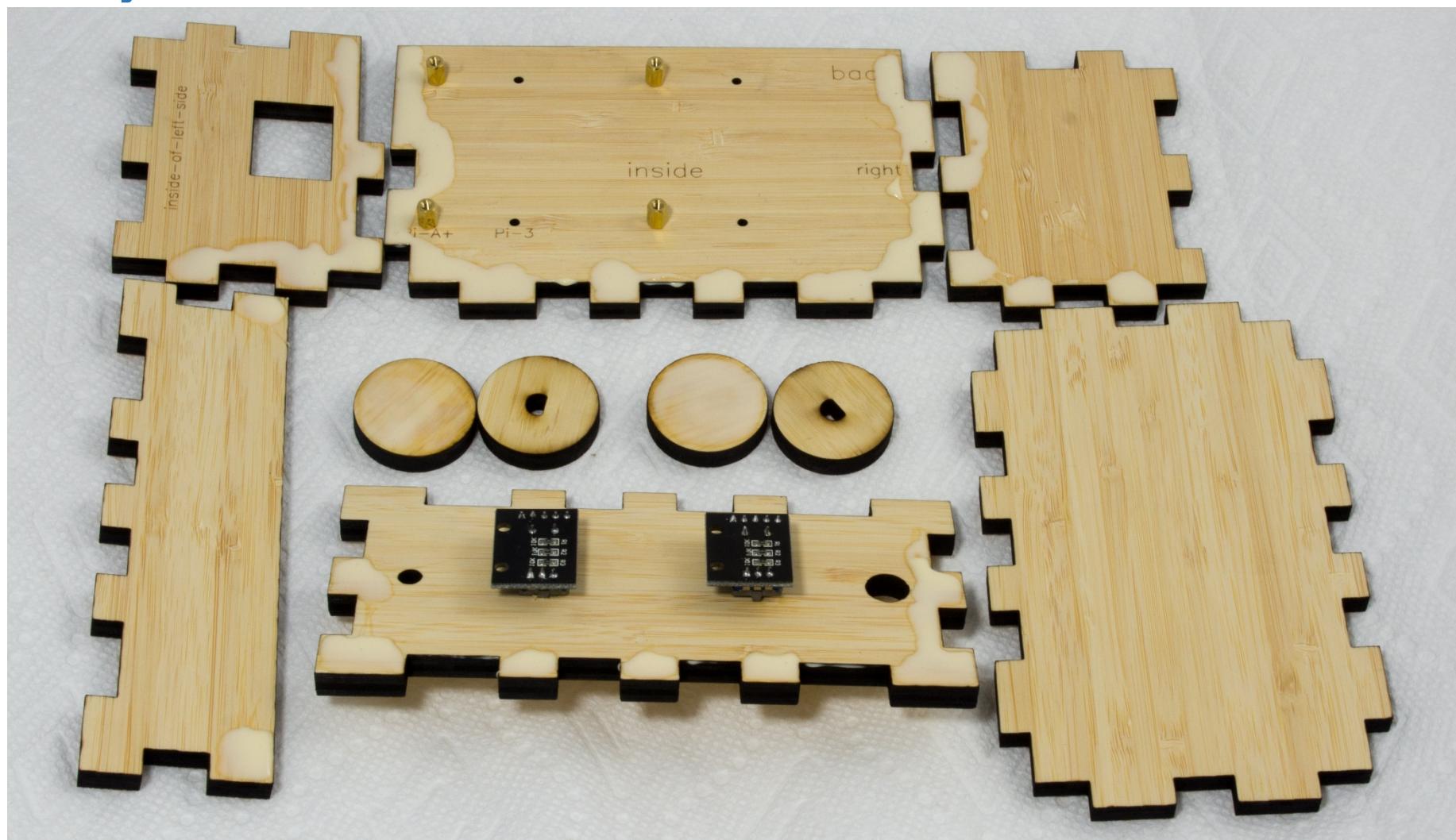
## 9.1 Screw in the standoffs



## 9.2 Screw in knobs (rotary encoders)

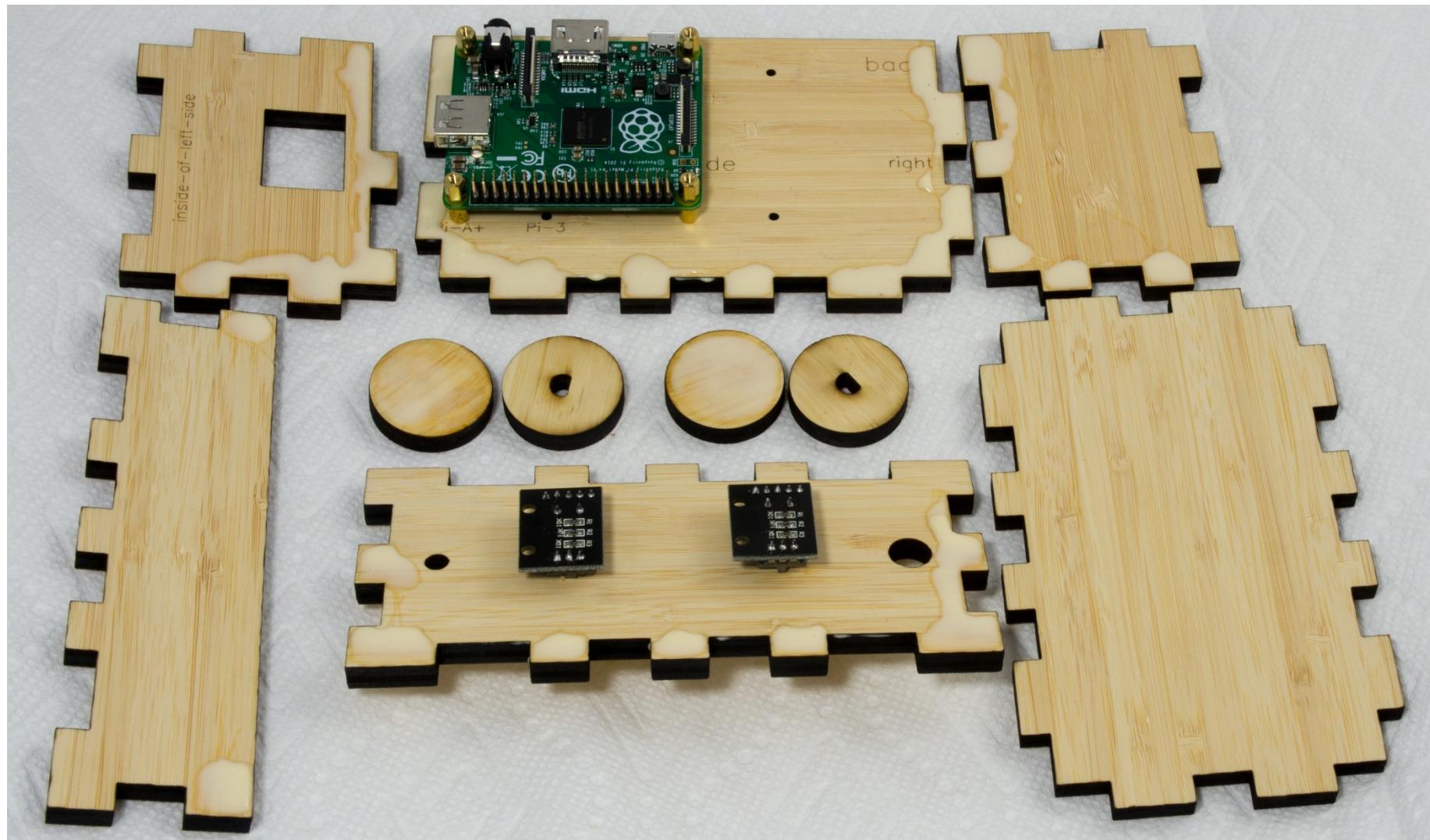


### 9.3 Add glue



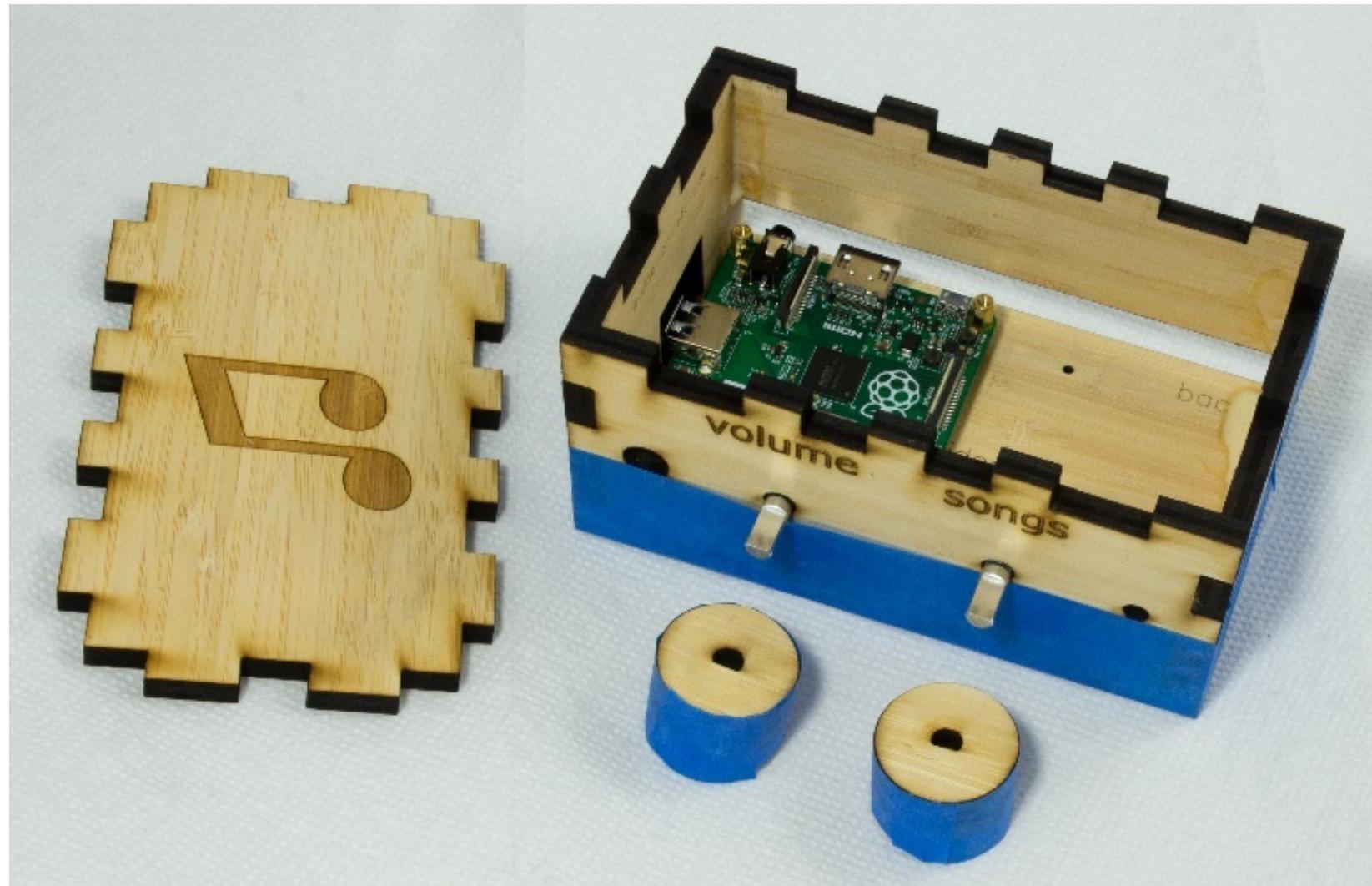
## 9.4 Add Raspberry Pi

To attach the Raspberry Pi, use four more standoffs.

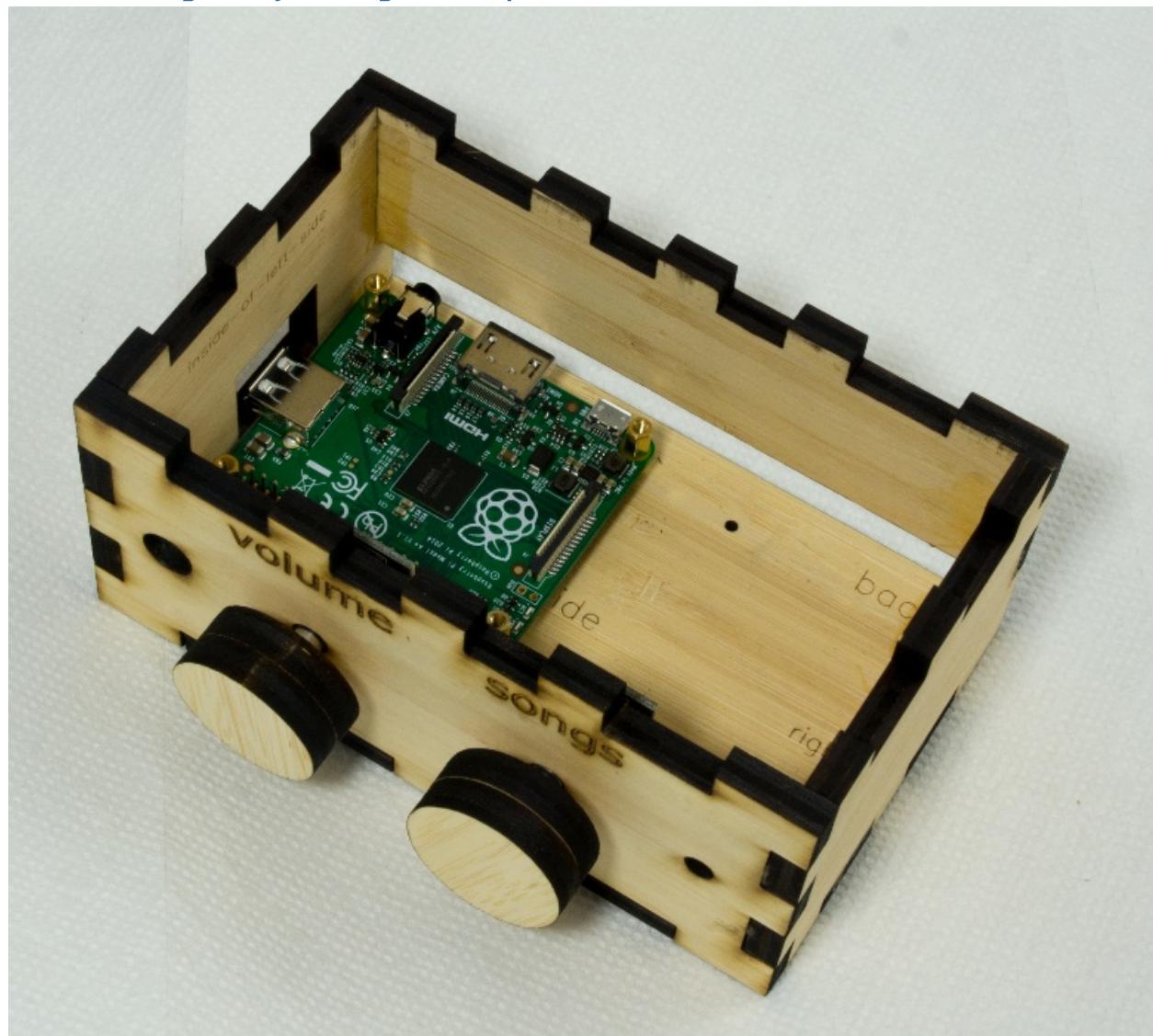


## 9.5 Glue all but the lid

Glue all but the lid together. To hold it together while drying, use painter's tape. After you have taped it, make sure that the lid fits. **But don't glue the lid on.** I suggest checking the lid fit again after 30 minutes. The lid should be fit snugly, but come off with a bit of effort. **Again, don't glue the lid on.**

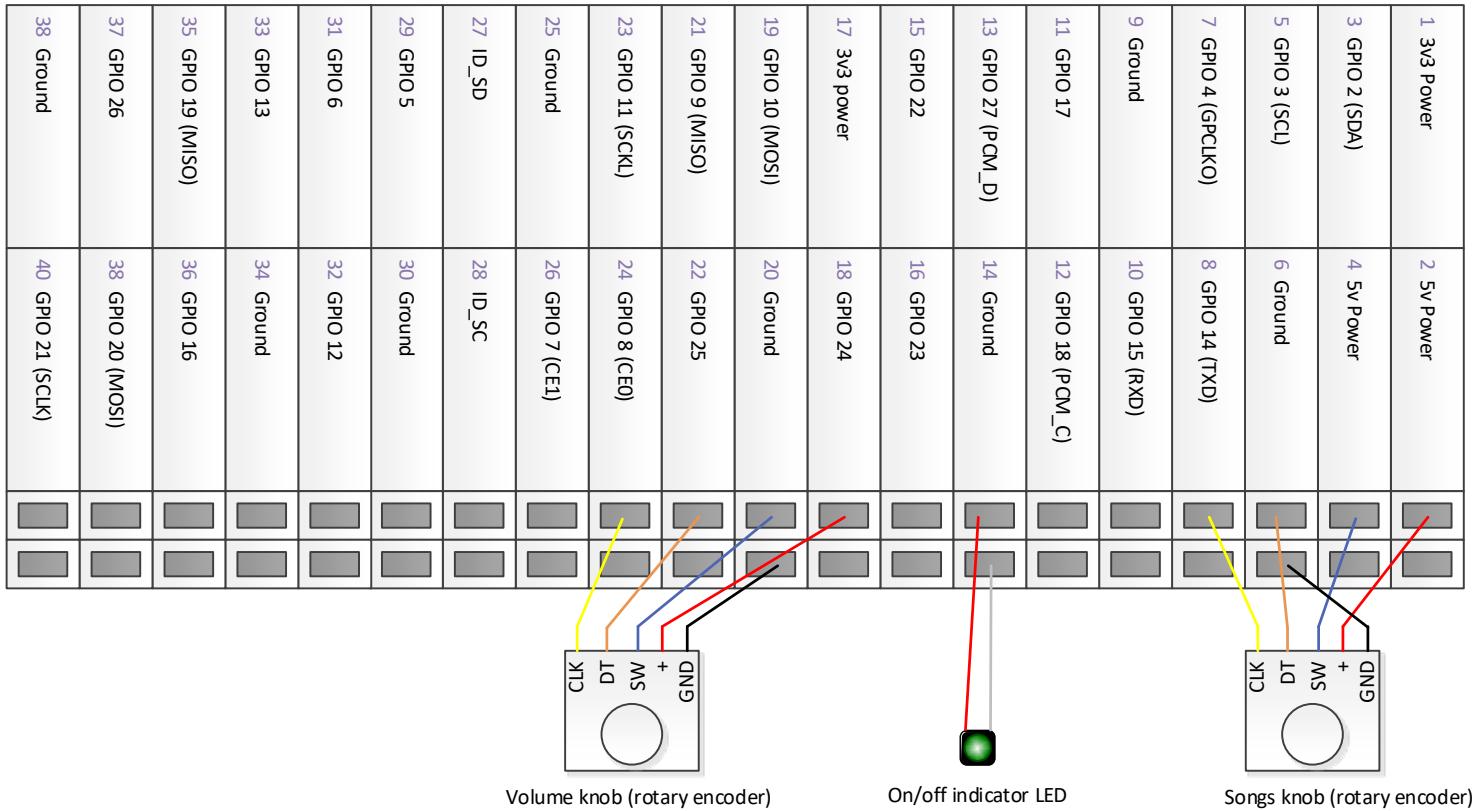


## 9.6 Let the glue dry overnight, then press to attach wood knobs

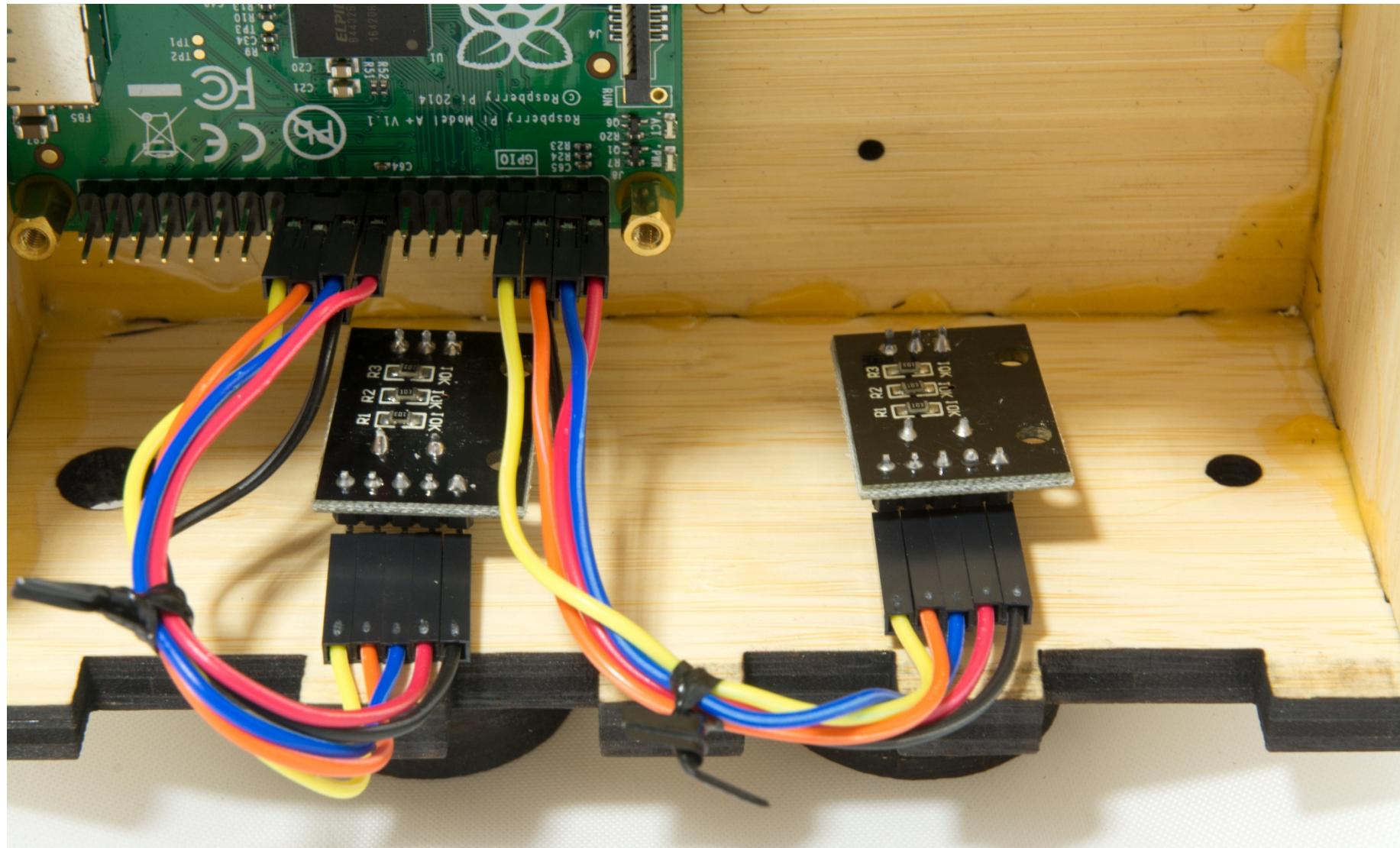


## 9.7 Wire up the knobs and the LED

Attach wires from the knobs and the LED to the Raspberry Pi as per the diagram and photos below. No soldering required – just press the wires into place.



For the knobs, the result should be:



For the LED, the result should be:

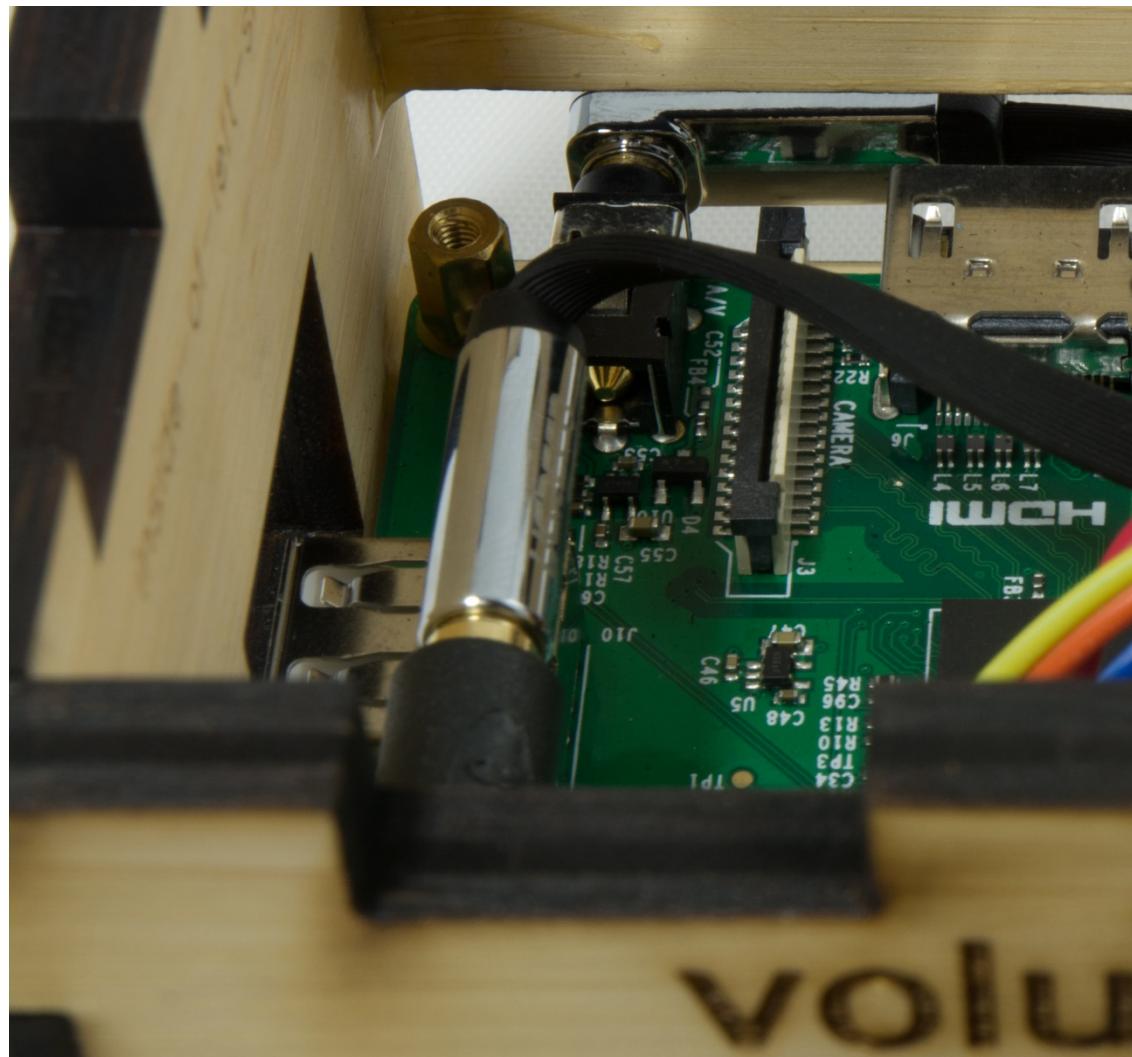


## 9.8 Screw in the headphone socket



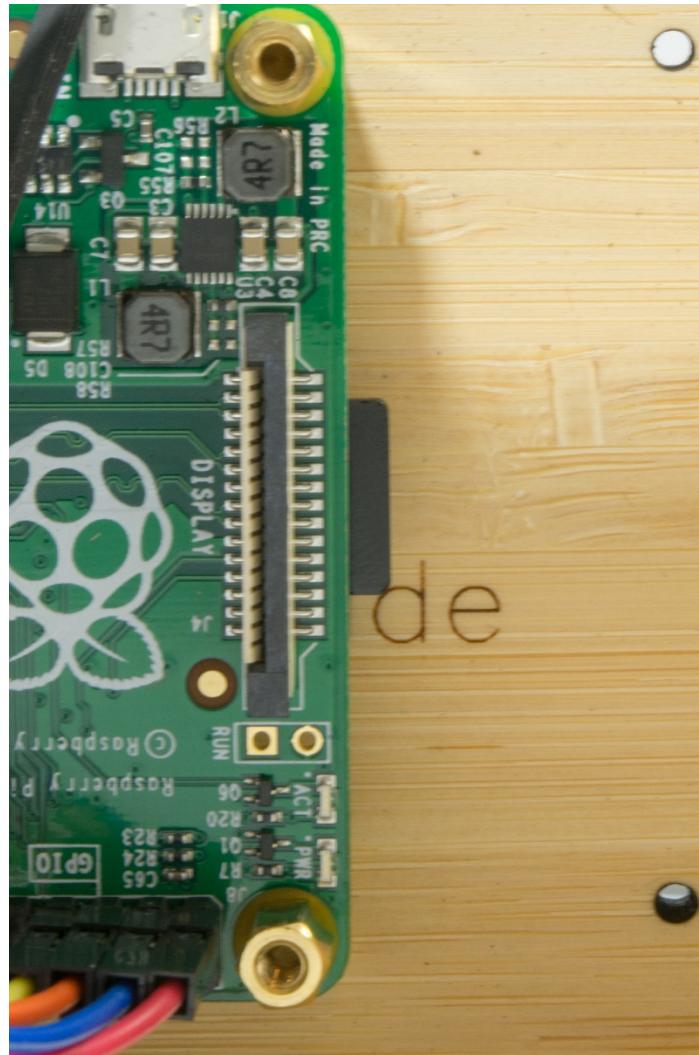
## 9.9 Connect the audio cable

Connect the audio cable from the headphone socket that you just installed to the headphone socket on the back of the Raspberry Pi, see the silver bits below:

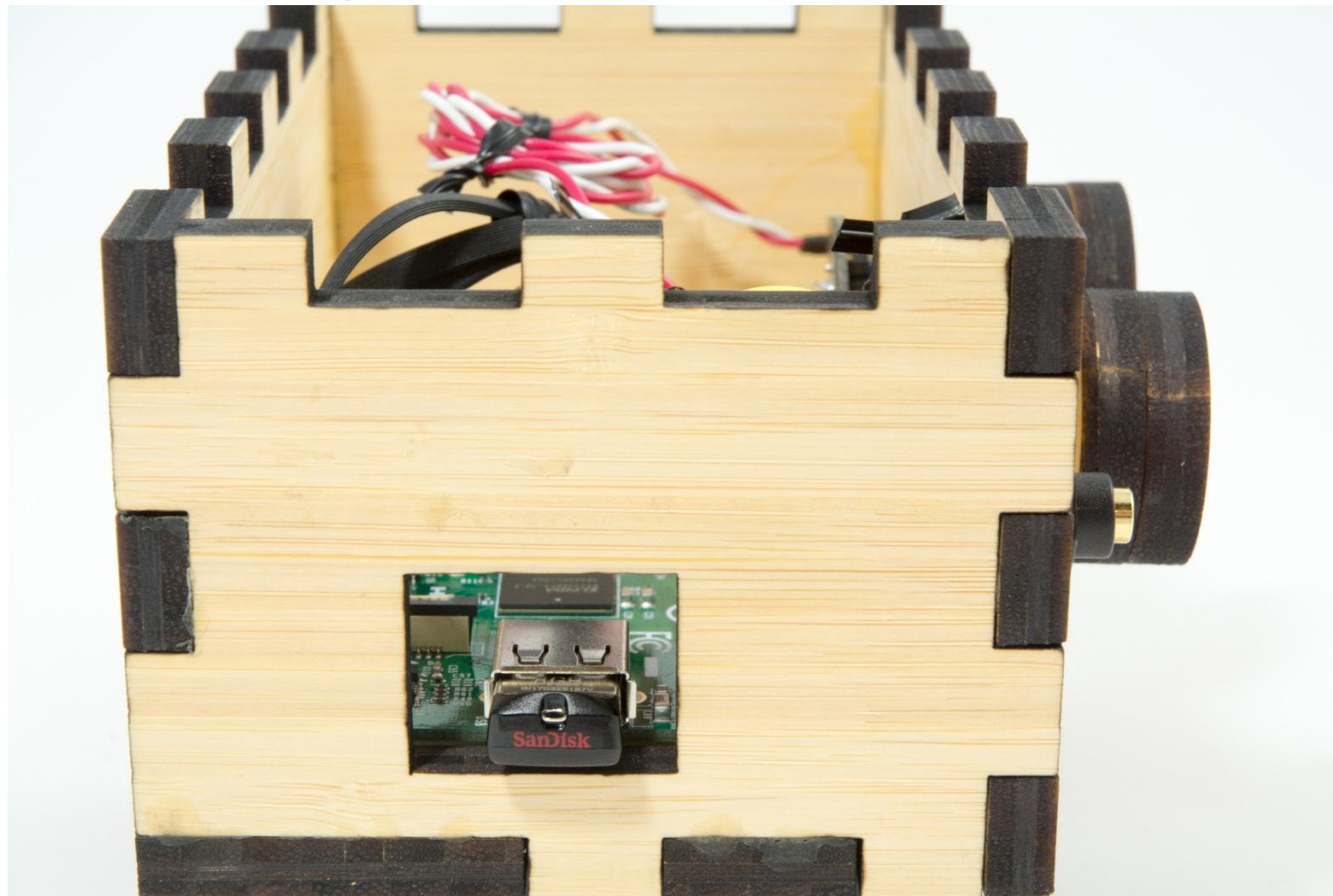


## 9.10 Insert the micro SD card

The micro SD card goes in a socket on the underside of the Raspberry Pi. Once inserted, only a small portion of the micro SD card is visible. See the photo below showing the micro SD card just above the letters "de".



## 9.11 Insert the USB memory stick (the music)



## 9.12 Put the lid on



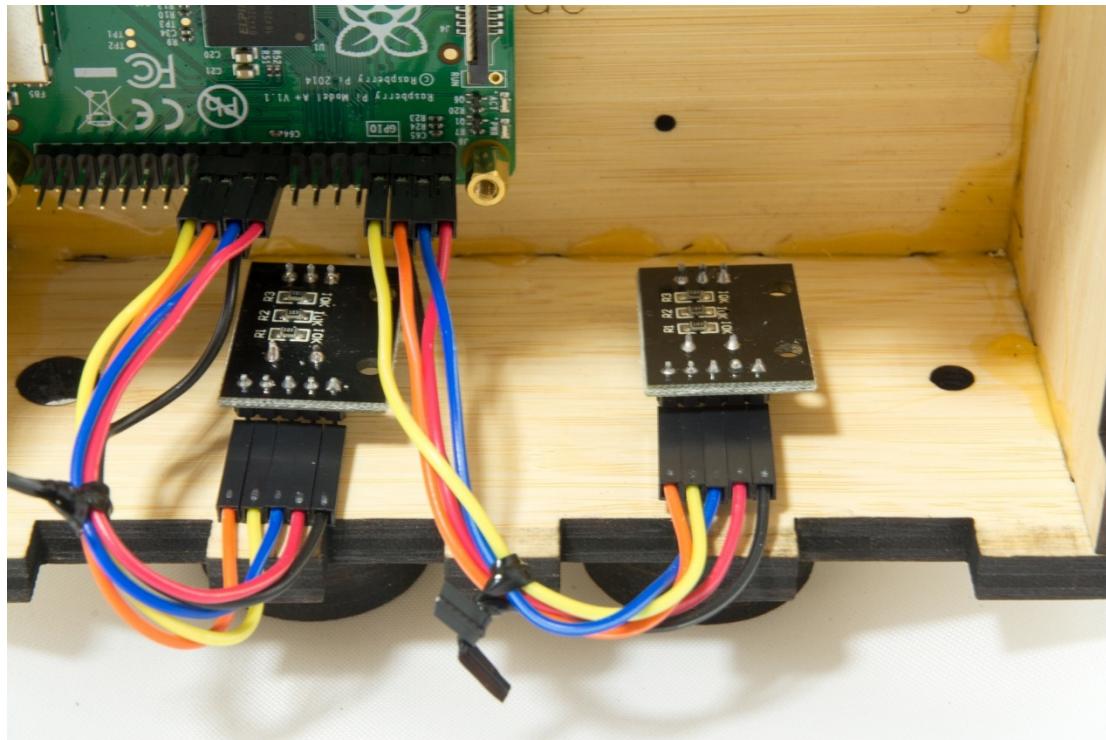
## 9.13 Test it

Now that you have assembled everything, it is time to test.

Test	Description & Expectation
Light 15sec after power on	The indicator LED turns on when DQMusicBox is ready to play music, which is generally about 15 seconds after power on.
Start song	Turning either of the knobs will start music playing.
Change song	Turn the songs knob. If you go forward and backward through the song list as expected, then all is well.
Change volume	Turn the volume knob. If the volume goes up and down as expected, then all is well.
Pause	Tap the volume knob, song should pause. Tap the songs knob, this should also pause the song.
Unpause	Tap a knob

## 9.14 If one or both knows do the opposite of what you expect

Once assembled, you may find your knobs doing the opposite of what you expect e.g. a clockwise turn decreases the volume. This is because there are two kinds of rotary encoders out there. Happy, the fix is easy, just switch the orange and yellow wires on the misbehaving knob(s) i.e.:

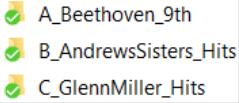


## 9.15 Tape instructions

Print this page and tape the instructions below to the bottom of your new DQMusicBox:

**To create personalized music**

**Organize the music on your computer**

 A\_Beethoven\_9th  
A\_Beethoven\_9th  
B\_AndrewsSisters\_Hits  
C\_GlennMiller\_Hits

One folder per album. Use MP3 files, must have .mp3 file extension. Or iTunes files (.m4a). Or FLAC files (.flac).  
Optionally, use folder names prefixes to specify the play order e.g. A\_, B\_

**Copy the music to the USB thumb drive**



1. Unplug your DQMusicBox.
2. Remove the USB thumb drive and place in your computer.
3. Copy music files from your computer to the USB thumb drive.
4. Put the USB thumb drive back in the DQMusicBox.
5. Plug in your DQMusicBox.

## 9.16 Congratulations

Congratulations! You should have a fully functional DQMusicBox.

## 10 Appendix 1: Write protect the SD card

### 10.1 About SD card write protection TMP\_WRITE\_PROTECT

This step is optional. It will increase the durability of the system. But it's only worth the effort if you or your friend are already work with Raspberry Pis. Here's the gist:

- Raspbian, including DietPi, don't generally like to be rudely shut down i.e. having the power plug pulled.
- Rude power downs can interrupt writes to the micro SD card.
- But we have a special case here, because DQMusicBox does not need to be online and does not need to be updated. In other words, it is safe to write protect the micro SD card.
- The SD card standard has a rarely used feature known as TMP\_WRITE\_PROTECT (which is a useful google search term) i.e. temporary write protection.
- When in this mode, the SD accepts write requests, but any such writes are made to temporary storage and are deliberately lost upon reboot or power loss.
- In other words, if you pull the plug on a DQMUSIXBOX you are effectively doing a factory reset. Music stored on the USB thumb drive is unaffected.
- References:
  - [SD Card Write Protection](#)
  - [Build the SD Locker and Make Your SD Cards More Secure](#)

If you have read this far, you want to do this, right? If so, read on.

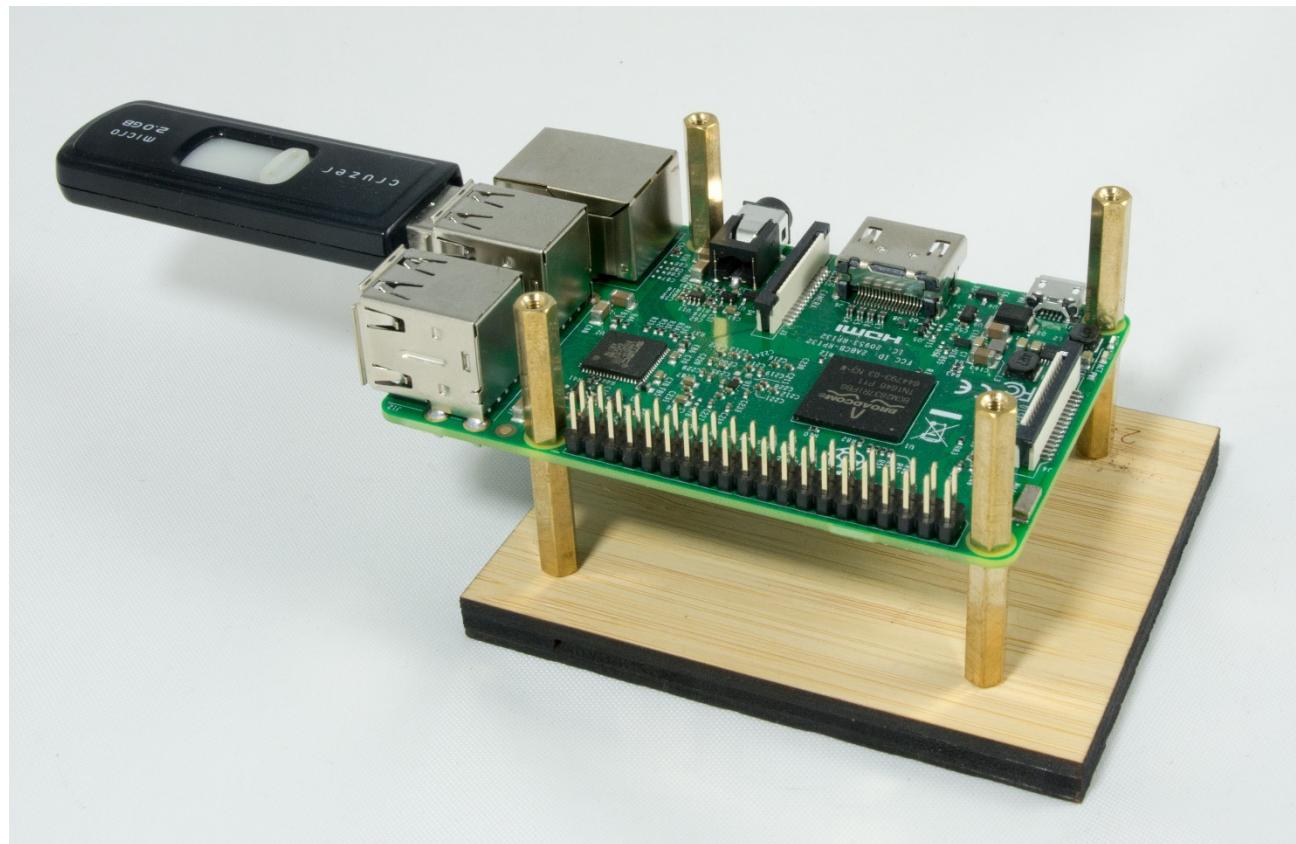
### 10.2 Option 1: Build the SD locker project

I used option 2, but this one looks like fun too. [Build the SD Locker and Make Your SD Cards More Secure](#).

## 10.3 Option 2: Use a Raspberry Pi 3

This is the option that I used. See my little setup in the photo below.

1. Follow these [instructions](#) to modify a Raspberry Pi 3 to boot from USB.
2. Boot from USB
3. Install the [SD Card Write Protection](#) tool.
4. Insert SD card that you would like to write protect
5. Issue the following command:  
`sudo ./sdtool /dev/mmcblk0 lock`



## 11 Appendix 2: Change log

v1, November 2015	Original release
v2, September 2016	<ul style="list-style-type: none"><li>Changed music storage from a micro-SD memory card to a conventional USB memory stick.</li><li>Changed the base Operating System from full Raspbian to <a href="#">DietPi</a> – much smaller, so faster to boot, and less to go wrong.</li></ul>
v3, January 2017	<ul style="list-style-type: none"><li>Changed from USB audio to Pi built-in audio, including a firmware update for excellent audio quality.</li></ul>
v4, May 2017	<ul style="list-style-type: none"><li>Switched to bamboo for durability and use of standoffs.</li><li>Switched to Pi A+ to lower cost.</li><li>Made USB thumb drive externally accessible, to make things easier for the caregiver to organize music.</li></ul>