**DQMusicBox: Requirements**3 January 2015

# About music for people with dementia

That’s DQ in the photo – my Dad. My son & I were inspired to make a music box by the documentary [Alive Inside](http://www.aliveinside.us/#land) -- it suggests that people with dementia come alive when listening to their favorite music. Following that suggestion, I put DQ’s favorite music on an iPad. There was sustained joy on his face – joy from the familiar music and joy from the fact that nothing else in the frustrating world mattered for a few minutes. My Dad is doing pretty well. But he can’t operate a traditional stereo or an iPad. But he can use DMusicBox without assistance. 

The DQMusicBox project is online – dqmusicbox.com. You are free to build what I designed.

This document assumes that you want to create a different music box. More specifically, it assumes that you want to make something that behaves like a DQMusicBox but has different internals. That’s great. This document lists some of the use-cases (requirements) that I thought about when making the first box.

# The assumed user interface -- two knobs

The intent is to create a music player for people with dementia. A key hypothesis is that the user interface must be simple and familiar. In other words it needs to be easy \*and\* not require new learning. For instance, if the music player operates like a simple device that the user has used throughout life. From this, I arrived at the idea of the two-knob-radio-like user interface:



You make take a different approach, but I think the above illustrates the idea of simple and familiar.

The requirements below assume this two-knob user interface. However, it does not assume anything about the internals. I used a Raspberry Pi to create the above, but you might use something different. In other words, I think the value of the current device is that the two-knob interface, not the Pi.

# Use-cases

## End-user

To keep things easy for the end-user with dementia, there are only three end user use-cases.

|  |  |
| --- | --- |
| **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. |

## Caregiver

The caregiver is whoever setups up the device or helps the end-user with the device. If you are reading this, you are probably a caregiver.

|  |  |
| --- | --- |
| **Name** | **Description & implementation** |
| **Pause music** | Ideally should be possible both explicitly and automatically.  **Current implementation.** music pauses if there are no knob events in one hour. Or you can tap on either knob. |
| **Shut down** | Shutdown so the device can be moved.  **Current implementation.** The device is intended to be left on all the time. But if you want to move the device, you can: long hold (15-30 seconds) on the volume knob.  **Notes.** You could do this differently e.g. a power switch on the back, but adding anything new to the front may make things more complicated or the end-users. |
| **Reboot** | Reboot in case the device misbehaves.  **Current implementation.** The device is intended to be left on all the time and is quite stable (so far). But if you want to reboot: long hold (15-30 seconds) on the songs knob. |
| **Add/remove music** | Add/remove music, especially when preparing the device for first use. Not needed often.  **Current implementation.** Done as part of the setup while the micro-SD card is still in the PC/Mac SD slot.  **Notes.** You should strive to include only the user’s favorite music. My hypothesis is that the user does not need a lot of music, given the memory issues of dementia, thus 20-80 songs is sufficient. If you choose the right set of songs initially, you may not need to ever change the set of music. The current implementation uses a micro-SD card that holds both the music and the operating system. So the caregiver has to mess with the SD card. You may be able to find a better way e.g. a USB flash for music. |
| **Add/remove music remotely** | Allow a caregiver to remotely add/remove music. Nice-to-have, not a hard requirement.  **Current implementation.** Caregiver SFTP through proxy to music box. |
| **Troubleshoot** | Provide diagnostic information. Nice-to-have, not a hard requirement.  **Current implementation.** Verbose logging. |

## System

|  |  |
| --- | --- |
| **Name** | **Description & implementation** |
| **Startup** | The device is intended to be left on all the time. Nonetheless, the startup time should be short, ideally perceptually instantaneous – like any other consumer audio device. The current implementation doesn’t do so well in this regard – takes about a minute to boot. |
| **Create playlist** | The songs should play in some sensible order e.g. alphabetical by album name. This is not an issue for the current Pi implementation. But it is surprisingly challenging for Arduino-based solutions. Thus this requirement should be considered. |
| **Sudden shut down** | The device should tolerate being unceremoniously unplugged. That is, it should behave like any other consumer audio device. The current implementation doesn’t do so well in this regard – it wants any orderly shutdown, much as laptops do. |
| **Security** | The device should have a known security plan. That plan could be that the device is not connected to a network. If the device runs a complex operating system (Linux, Windows, …) and is connected to a Network then it should get regular security patching, ideally without caregiver intervention. |

# Design notes

This section is simply a place to put thoughts about design so they don’t get mixed in with the requirements above.

## Who is the buyer?

My assumption is that the buyer is a caregiver e.g. the spouse or child of the person with dementia. That sort of buyer is also in the best position to assemble the personalized collection of favorite music. This buyer may not overly price sensitive. This is really as much about quality of life as it is about fun. Additionally, the penalty for a device that doesn’t work well is likely that the dementia patient won’t use it at all.

## High-level options

|  |  |
| --- | --- |
| **Name** | **Description & implementation** |
| Pi with Raspbian | The current implementation can use either a Pi 2 or a Pi A+. A Pi Zero should also work fine (thought it would require soldering). Might be able to find a package will read music from a simple FAT32-formatted USB stick (does DietPi distro already have this?). Could add a small battery to solve the rudely-unplugged-shutdown problem. The current implementation uses a USB audio adapter -- this is the most common and economical audio adapter options. Others include: HDMI audio extractor, HAT. Note that if two USB ports are needed (USB audio, USB stick), then a PI A+ is presumably eliminated as an option. |
| Pi with Windows IoT | May have better support for music-on-USB-stick. Looks like it is possible to get music & files from OneDrive, but it also looks like this would not be easy for the caregiver. |
| Other single board computer with Linux | e.g. [C.H.I.P.](https://www.kickstarter.com/projects/1598272670/chip-the-worlds-first-9-computer/description) ($9 on Kickstarter, has headphone jack, not sure of audio quality), Banana Pi, Orange Pi. There are many other single board computers out there as well. |
| Arduino Uno + MP3 shield | AdaFruit and Sparkfun have such shields. Use an internal micro-SD card. Good support e.g. good library, good instructions. There are many other shields e.g. this one with USB: [generic MP3 shield](http://www.gearbest.com/transmitters-receivers-module/pp_241557.html), but I don’t know how good the library is. |
| Standalone board - Sparkfun Arduino Lilypad MP3 | Aruduino + MP3 on one board. Uses an internal micro-SD card. Seems to have good support e.g. good library, good instructions. |
| Custom circuit | Design the board… |
| Standalone MP3 board (no Arduino) | e.g. [ebay #1](http://www.ebay.com/itm/TF-card-U-disk-MP3-Format-decoder-board-module-amplifier-decoding-audio-Player-/331509915652?hash=item4d2f87e004:g:c0wAAOSweW5VC~QV) $1.79. A key challenge here is how to translate the rotary encoder motion into digital signals (Next, Prev, VolUp, VolDown, Pause/Play). Perhaps there are chips that will do this e.g. [LFLS7184-S](http://www.usdigital.com/products/interfaces/ics/LFLS7184-S), [ELM404](http://www.elmelectronics.com/DSheets/ELM404DS.pdf), [this discussion](http://forum.allaboutcircuits.com/threads/convert-rotary-encoder-movement-to-up-down-output.46509/). |
| MP3 player guts | Use the board from an actual MP3 player, connect to the knobs. Same challenge as above – translating the rotary encoder motions into digital signals. |
| Full MP3 player inside | Full MP3 player inside the two-knob wood case. Would have to be an MP3 player that accepts external comments e.g. via USB or via the headphone jack. To add/remove music, the caretaker simply pulls the MP3 player out of the two-knob box. In essence, the two-knob box is an MP3 player dock that happens to have a lid and controls. |

## About Raspbian, micro-SD cards, power, and reliability

Several of the above options use Raspbian. There are some issues:

* Raspbian doesn’t like to be unplugged prior to shutdown.
* The default Raspbian distribution is OK on the Model A+, but not great.
* With the default Raspbian distribution, micro-SD cards have the reputation for sometimes dying after a few months, particularly if a lot of writes are made.
* The default Raspbian distribution is somewhat slow to boot.

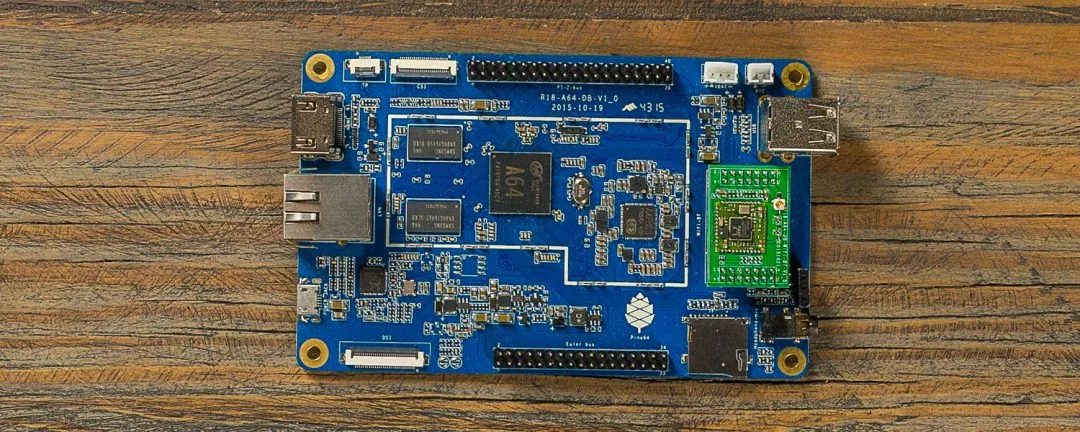
A few thoughts:

* A battery could be used for safe shutdown, but this would significantly increase the cost.
* There are some distributions e.g. DietPi that address reliability and performance by minimizing features/packages and by minimizing writes. I suspect that these same distributions are more tolerant of unexpected shutdown.
* There are also instructions online for creating fully read only installations.
* There are also instructions online (somewhat complicated) for booting from USB rather than from Micro-SD.

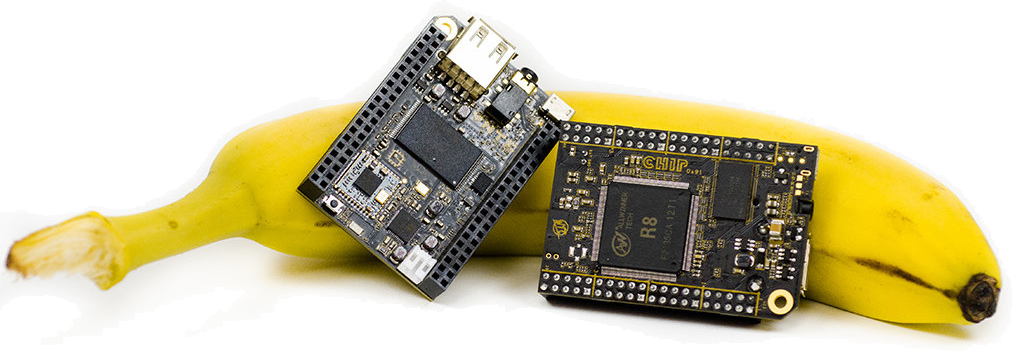
## Gating criteria

* Can create two knob user interface?
* Reasonable prognosis of reliability.
* Available now or soon.
* Sufficient/good audio quality? Doesn’t have to be awesome.
* Secure e.g. doesn’t require an Internet connection of does some audio updating.

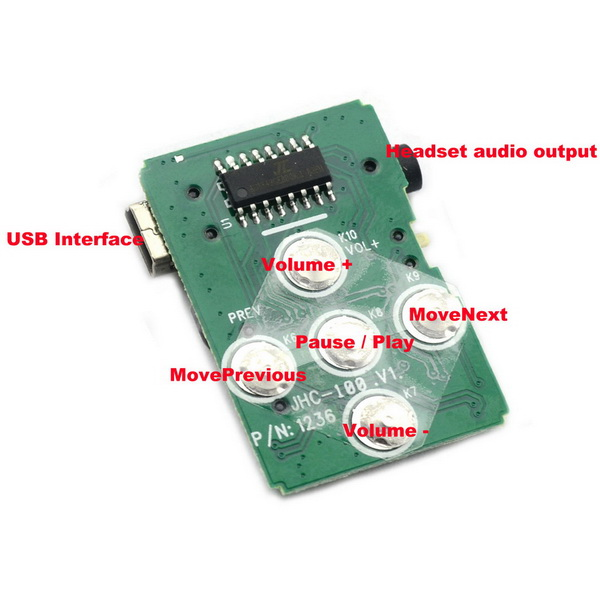
## Misc component photos

  
Pine64 SBC - available in March  
Audio quality unknown

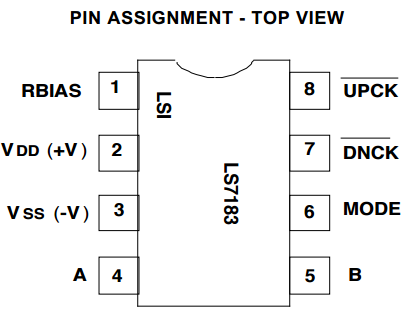
  
Banana Pi (original)  
Audio quality is good

  
C.H.I.P. - $9 single board computer available in June  
Audio quality unknown





MP3 decoder board from GearBest - $2.25  
I don’t know anything about this board



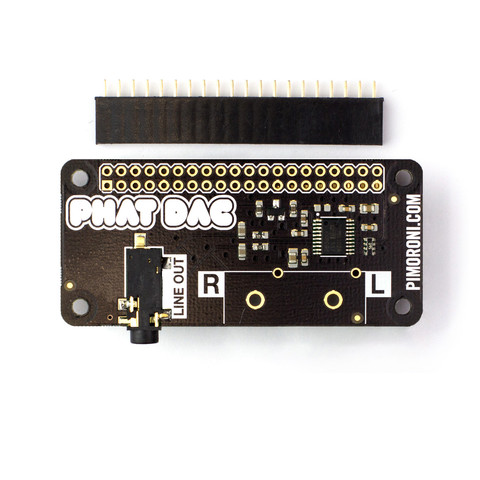
Chip that decodes rotary encoder signals e.g. clockwise → UPCK  
Would need one chip per rotary coder



MP3 shield available from Gearbest - $20  
Note USB for music, connections for functions e.g. VOL+, NEXT



Seedstudio Music Shield v1.0 (old) - $8



Pi Zero sized pHAT DAC. $18? Available? Line out works with headphones?