

# ATPLAY

Bit-Perfect, HDD/USB 24/96 Integrated Audio Player

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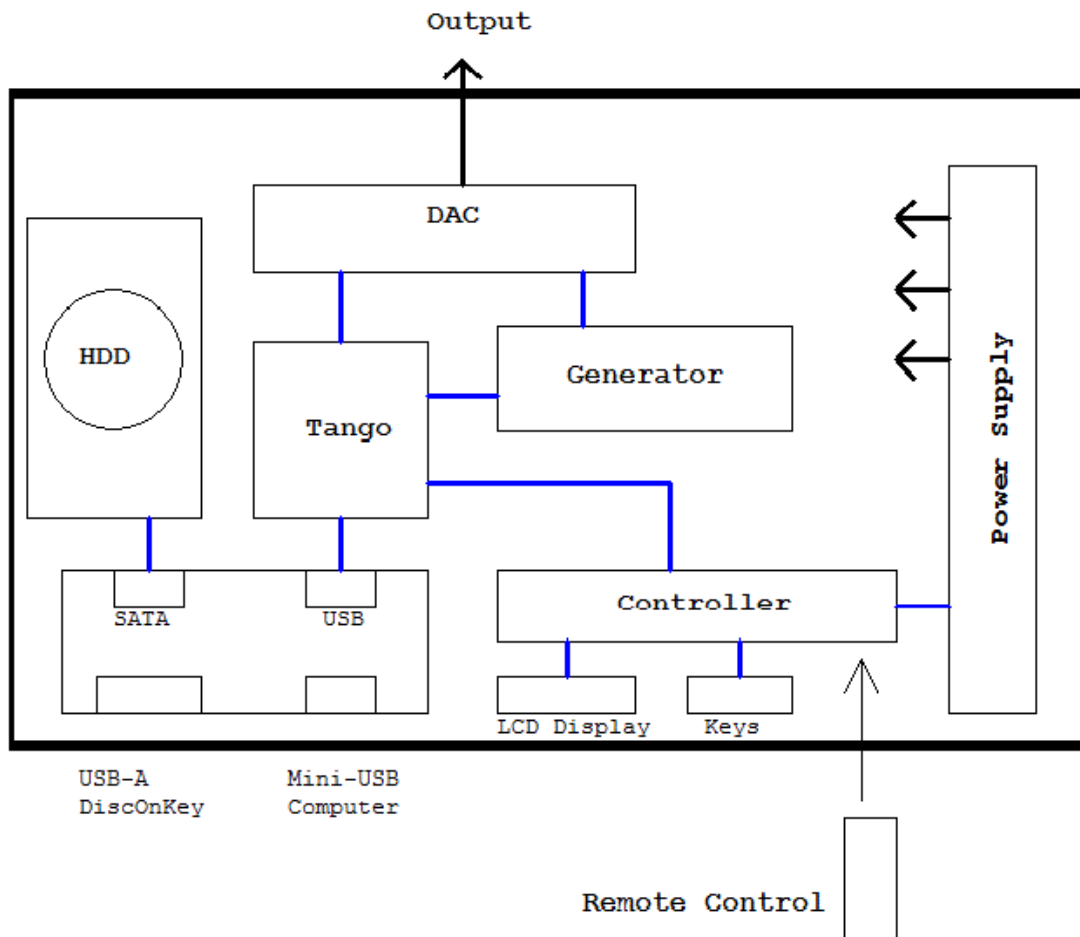
Many times, looking at the cabinet with the disks, I think "how to shrink this all?" (WAF here also has to be taken into account!). In addition, the permanent attempts of a sound quality improvement does not allowed to stop, and nevertheless I ear the concept of a "rising influence by the end of" (i.e. that, at the quality of the sound is most influenced by the loudspeakers and room, then amplifier, and then the source signal), but finally the time has come about the source.

I will not speak here about the analog sources (yes, I still use LP), and, as digital I use CD and DVD-Audio discs. Recent interesting its high resolution formats (24 bits, 96 and 192 kHz) as well as multichannel. Because of this, the idea of "hard player» comes into my head a lot of times during many past years. Fortunately, thanks to my job, I have some experience in microcontrollers, in particular their communication with flash memory, CD-ROM, HDD, etc. (more than 10-years ago project using HDD/CD-ROM at the 8-bit MCU had culminated in the hobby project - "CD-ROM Controller", i.e. in fact it was audio player with the computer CD drive). A lot of people deals with the similar projects and some of them are very close to finish, with varying level of functionality.

I have decided to postpone my own projects in this direction, and to take advantage of the fact that there are already ready. Actually, I had to choose from two similar devices - the two have a USB port, to which you can connect USB Disc-On-Key or USB-HDD. Both devices have control buttons and IR remote control, both can operate with simple LCD display. The first device although can use flac files, but it was limited to only one format - 16/44, while the second - realizing only WAV, it was able to reproduce any formats up to 24/96.

I believe that it is time to make some remarks, although this must be write in the beginning - all of the options of "hard players", at which I worked, also those considered as an alternative, must not only contribute to reduce space of the disks, but in the first - it should be more sound quality than that of conventional CD and have to be connected (or to have inside) a high level DAC (converter digital signal to sound). Because, if more high-quality sound is not to be, the savings in the disk no longer interested - MP3 is still less, and all kinds of MP3 players are available on the market, for any taste, colour and price. The main problem in CD is optic-mechanical information reading from disk, not guaranteeing 100% reliability (those is the standard of the Red Book) and accurate transfer of the data to DAC. As in the information (the bits accuracy) domain, and also in the time domain - if bits are accurate, but are not in the right place at the right time, the sound will not be good (the jitter problem).

God Thanks, USB-Flash and HDD are not working according to the Red Book, and the first problem simply does not exist (otherwise, our computers will not work), and the second problem - it should be resolved by DAC clocking with a high-quality generators, with a lower jitter. And the same signal should clock the digital data transfer from the reader (transport) to DAC. And it would be best to use not the standard SPDIF/TOSLINK interfaces, but the I2S bus. So the following block diagram was developed:



Both mentioned above transports do that, but I chose the second one (its name is "Tango", ARM-based). As from the very beginning, using of HDD as drives was considered (USB-flash maybe more convenient, but today are still more expensive), the were not a problem with the files size, and therefore I can live without flac. But support of the high resolution formats, up to 24/94 is great. 2 clock generators must be provided, in order to have two frequency scales - "normal" scale (44.1 and 88.2) and the "computer" scale (48 and 96).

So transport was selected. And it was decided that it will be not only transport, but the full audio player, with its own DAC inside. But there is a problem with the control - in the reference design a small LCD with I2C bus was used, which I do not have and which view I do not like. Or RS232C can be used, with computer (through the terminal software, like Hyper Terminal, Tera Term, etc.). IR remote control works only with Philips RC5 protocol. (A long time ago I developed universal software, to work with IR RC several standards that can learn a command from any remote control unit, working in one of the 5 standards, ported to some different microcontrollers)

As a result, I did not used Tango's own controls and made my own control unit instead. Based on TI's MSP430 microcontroller, this unit provides information on a large format LCD display - 4 lines of 40 characters. Can learn the commands from any remote control unit,

working according to RC5, NEC, Panasonic, Sony (sirc) or Samsung protocol. 6 buttons for the direct control from the front panel were implemented:

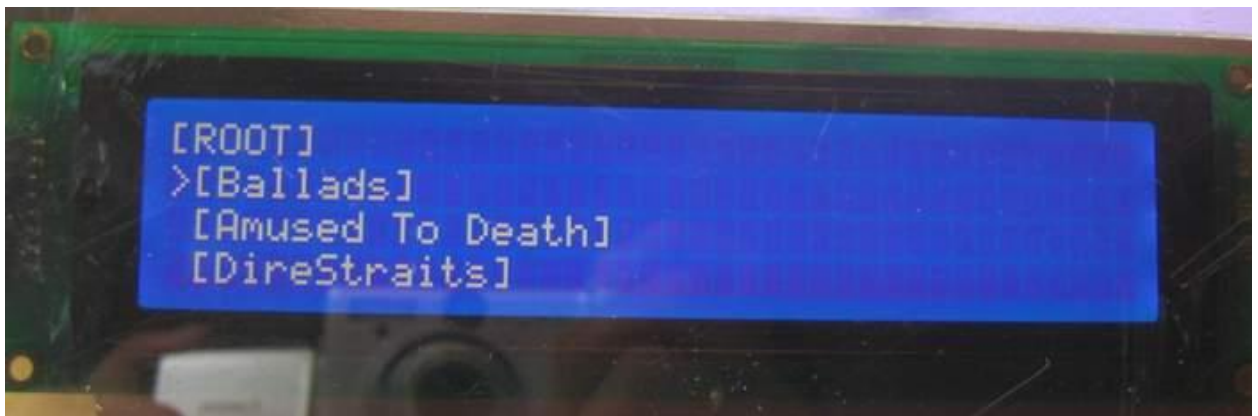
- STOP-Directory Out-On/Off
- Play-Directory In
- Rev-Previous Track
- FF-Next Track
- Previous Directory
- Next Directory

In Play Mode, LCD display have information about the track number, track time, track quantity in the current directory, directory and track names, also the current track information (bits, sample rate). The special technology was used to show the big digits on this type of LCD.

LCD in Play Mode:



LCD in Navigation Mode:



Storage Device (Disc-on-Key/HDD) must be in FAT32 format. Not only WAV file are supported, also CUE (with one or separate WAV).

As you can see at the block diagram, device consists of the following parts:

- Tango - USB Transport, RS232 controlled
- DAC (Analog Devices AD1853 based)
- Low Jitter Double Frequency Clock Generator
- Control Unit (with LCD, Remote Control and front panel buttons)
- HDD
- Source/Path Switch
- Power Supply



Notice a lot of transformers in the Power Supply! Yes, total separation of power - is “must have” for an excellent sound quality. The biggest transformer in the right bottom is for HDD and Tango. One transformer power the Clock Generator. One transformer is for a DAC’s digital VCC, one is for DAC’s analog VCC, and one is for DAC’s output filter/buffer.

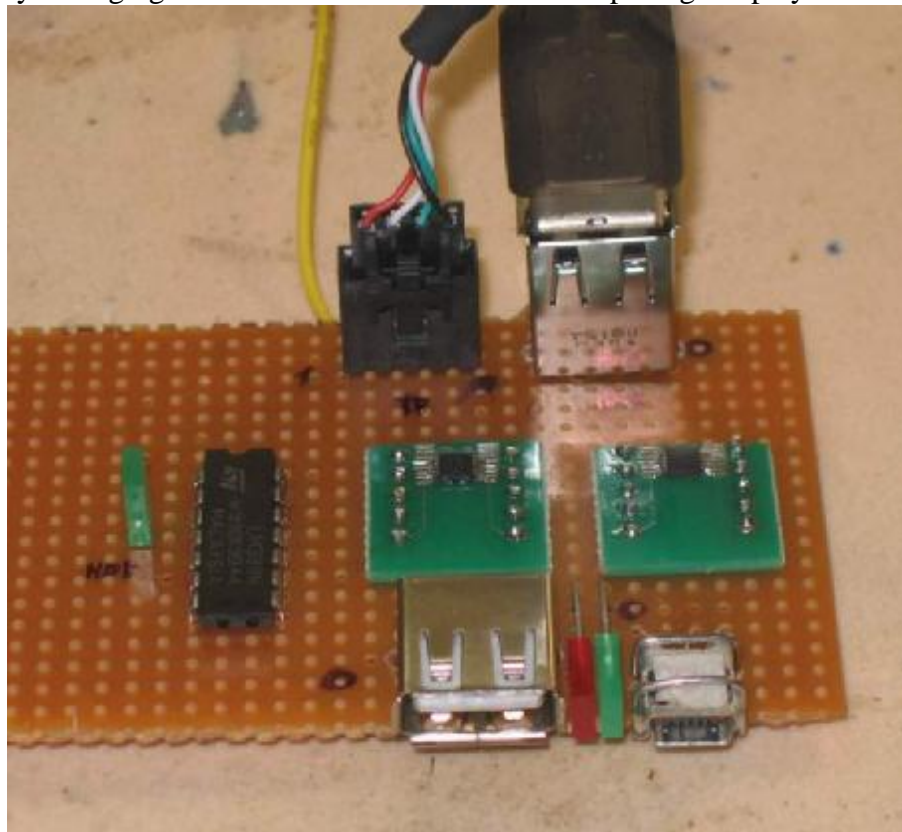
It is now shown on this photo, but there is another small transformer, who powers the Control Unit. This transformer is “on duty”, it works all the time. When the “power” button was pressed on the Remote Control Unit (or front panel button), the Control Unit switches on all other transformers.

As HDD I used 1T 3.5” Western Digital Caviar Green 1TB IntelliPower WD10EARS drive. It is cold and quit. By the way, with this HDD, dedicated power supply can be reduced. What you see on the picture – was used during experiments with HDD with much higher current consumption.

Source/Path switch (small yellow prototype board on the right top) is intended to switch storage device between the internal HDD and external USB Disc-On-Key. Notice 2 connectors under the display:

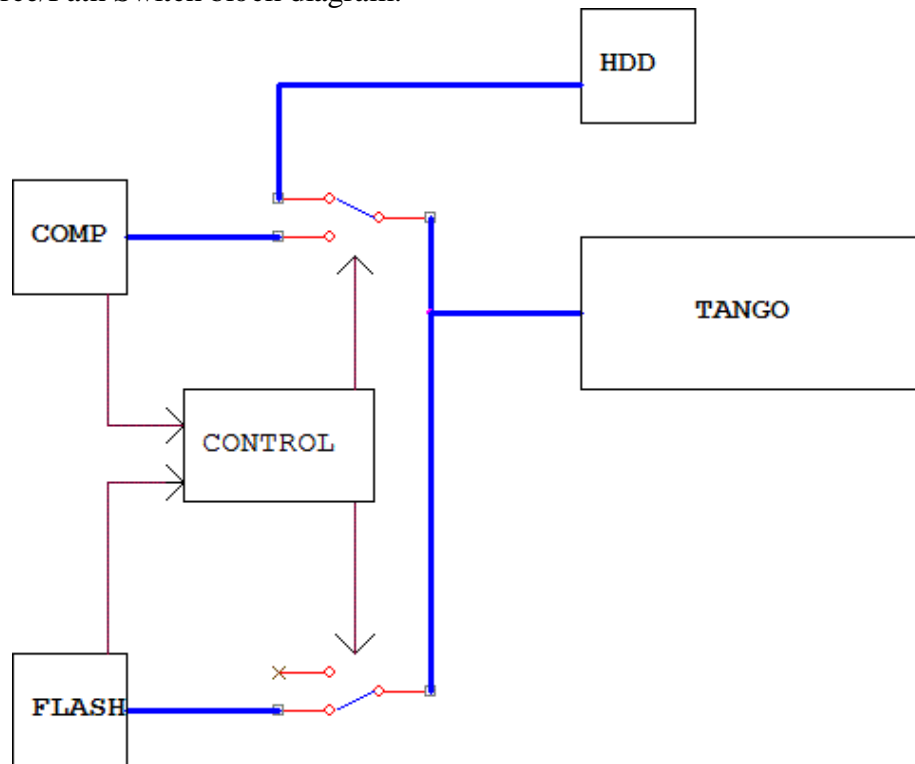


Left USB-A connector – is for Disc-On-Key, right mini USB – is to connect computer. In the last case, the internal HDD is disconnected from the player, and operate like external drive. This is for easy managing audio files on this HDD without opening the player.



It is prototype board used for Source/Path Switch, later this was changed to the normal 2 layers PCB. Also USB/SATA convertor was located on this PCB.

Source/Path Switch block diagram:



This device is totally “home made”. Standard 19” 2Ucase was used, only its front panel was replaced. As I don’t have heavy equipment for metal processing at home, front panel was made from wood. For wood I have some tools, even the router and the router table (also home made) and air compressor for painting, thanks to my loudspeaker design practice.

Front Panel was made from plywood:

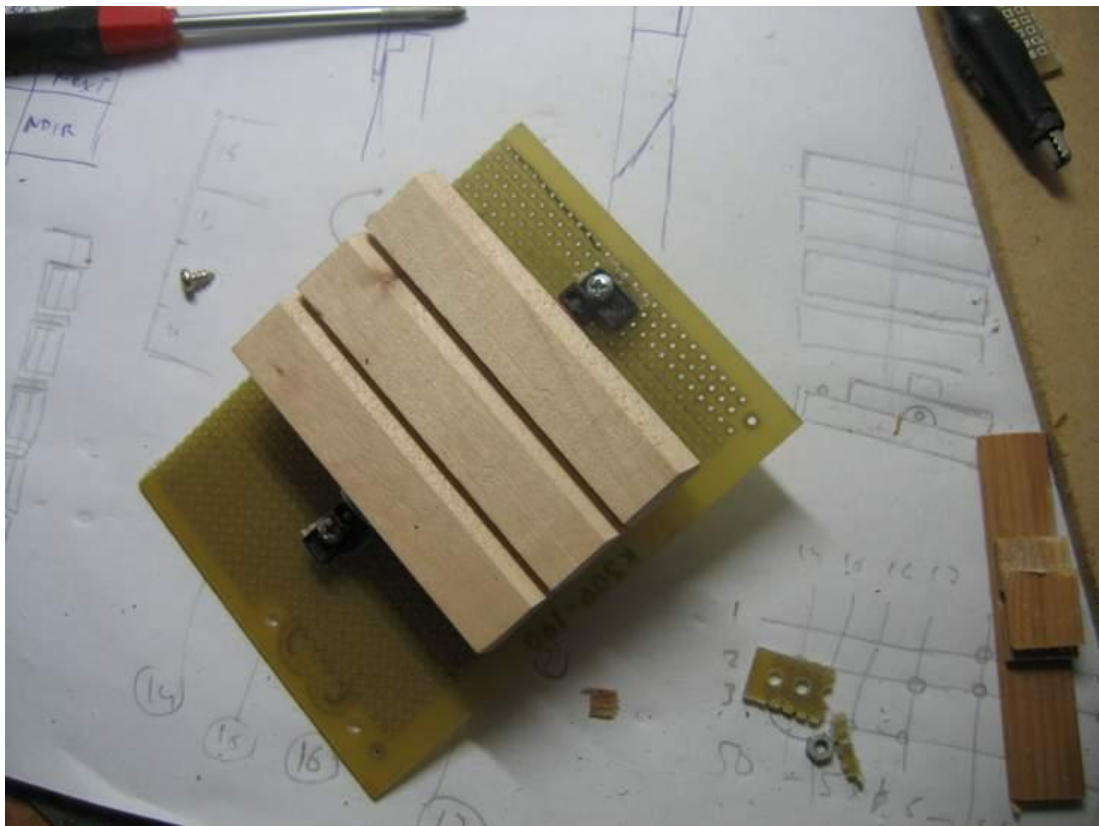
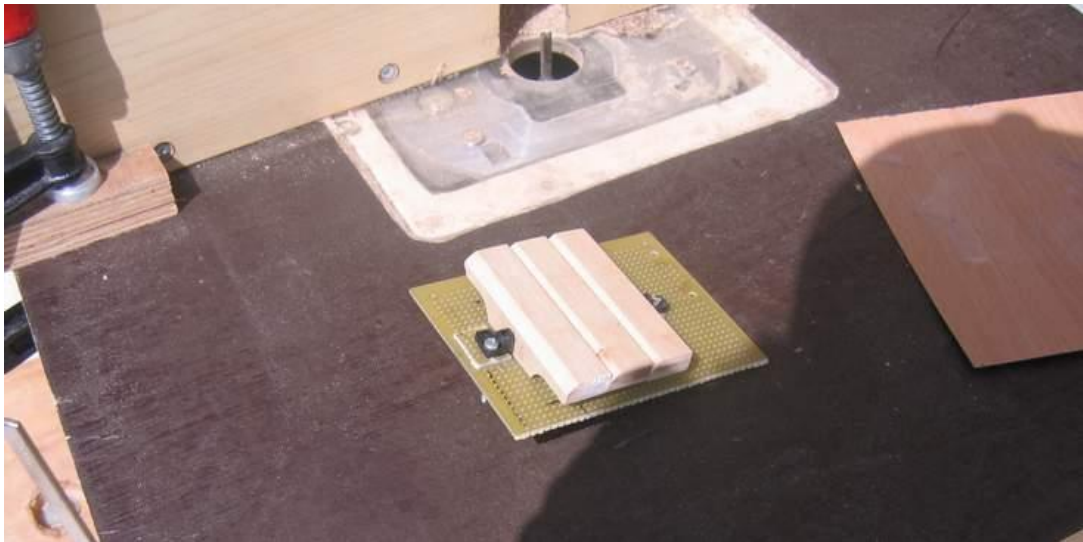


After the routing, it was covered with veneer, painted and lacquered.



Front panel buttons were also made by the same technology:





You see 3 parts, operates as 6 buttons - these parts were mounted on an axis at the PCB piece. There are 6 pushbutton switches under these parts.



Maybe this player does not look like ‘industrial made’, but its sound is excellent. Of course, I will not stop to develop another versions, this model can substitute CD-Player, but I still need DVD-Audio Player to listen 24/192 format, and 24/96 5.1 multichannel. Also I have some ideas to another control and topology.



What I need – is to say “thanks” to Tango’s author, and everybody who took part in this player development, by their help, advice, component purchasing, listening, etc.

Alexander Torres.