

Set-top box IPTV

Customer

Smartlabs is a leading Russian-based developer of digital interactive television (IPTV, DVB, hybrid, satellite and Internet TV), modern client applications and user interfaces for TV set-top boxes, new-generation service platforms, OSS/BSS and CRM systems as well as other innovative solutions for communications providers and corporations.



Objective

The objective was to develop a user digital TV set-top box for IPTV content operators, which would enable IPTV content reception and decoded stream playback on a TV set in the SD and HD formats (up to 1920x1080 60Hz). The hardware platform should be based on the STi7105 processor by STMicroelectronics. This device should decode MPEG-2/4 video streams as well as connect and play back data from an embedded HDD. The set-top box should be fitted with the following interfaces:

- Ethernet
- HDMI
- Component Video output
- Composite Video output
- Stereo Audio output

- S/PDIF
- 2xUSB
- IRDA
- On-board RF-receiver and RF-based remote control
- 2-x microphone inputs for dynamic microphones

The set-top box is designed for the middle end of the market and should be implemented in the minimal form-factor. The software should be based on the Linux operating system.

The development team had to fulfill the following tasks:

- Calculation of the bill of materials cost of the device for its mass production
- Development of the STB enclosure design and structure
- Selection and optimization of the cost of the elements base as well as elements base adjustment to the manufacturer's requirements
- Development of a principal circuit
- Printed-circuit board tracing
- Production and adjustment of trial samples
- Development of test software
- Adaptation and assistance in the production launch of the device

Solution

STi7105, a processor by STMicroelectronics, has been chosen as the key component for the set-top box. The most important feature about this processor is a high degree of integration and location of video and audio codecs, the processor core for Ethernet user applications, as well as the HDMI and USB controllers on one chip, which gives a competitive edge in the cost and size of the final device. STMicroelectronics provides full support and technical maintenance at the product development stage and offers adjusted solutions for Linux-based software implementation.

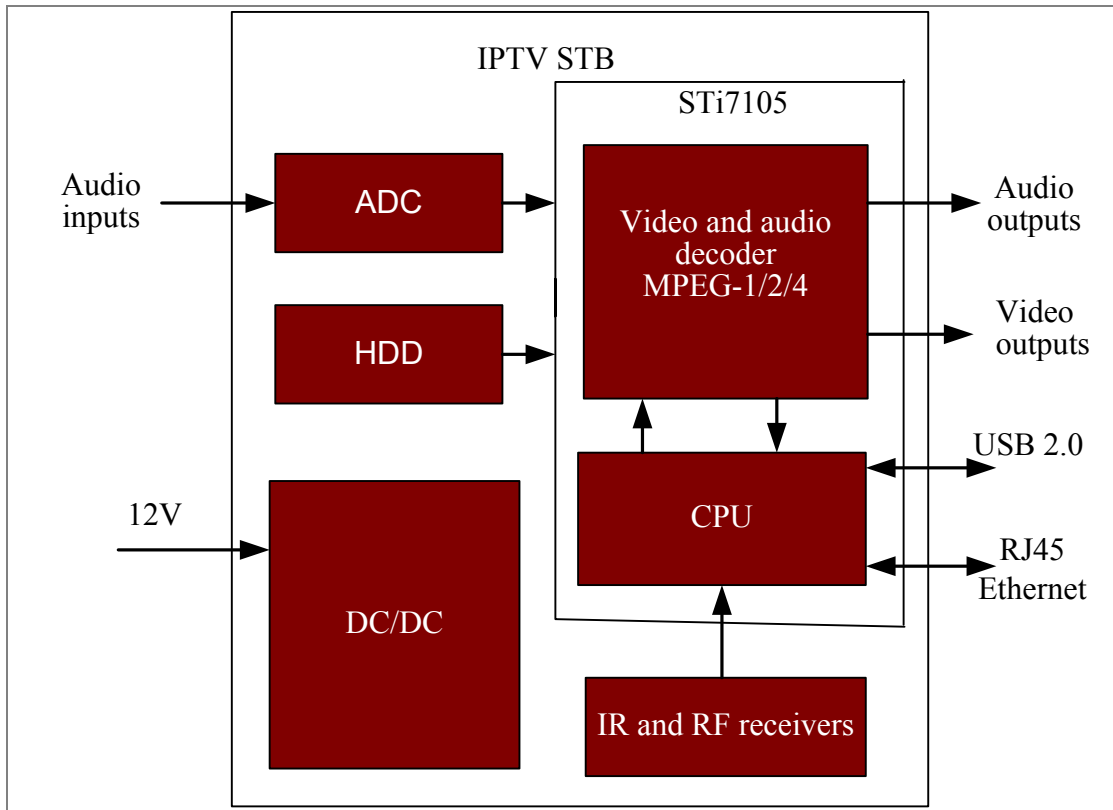


Figure 1. General structure of the device

1. Hardware Design

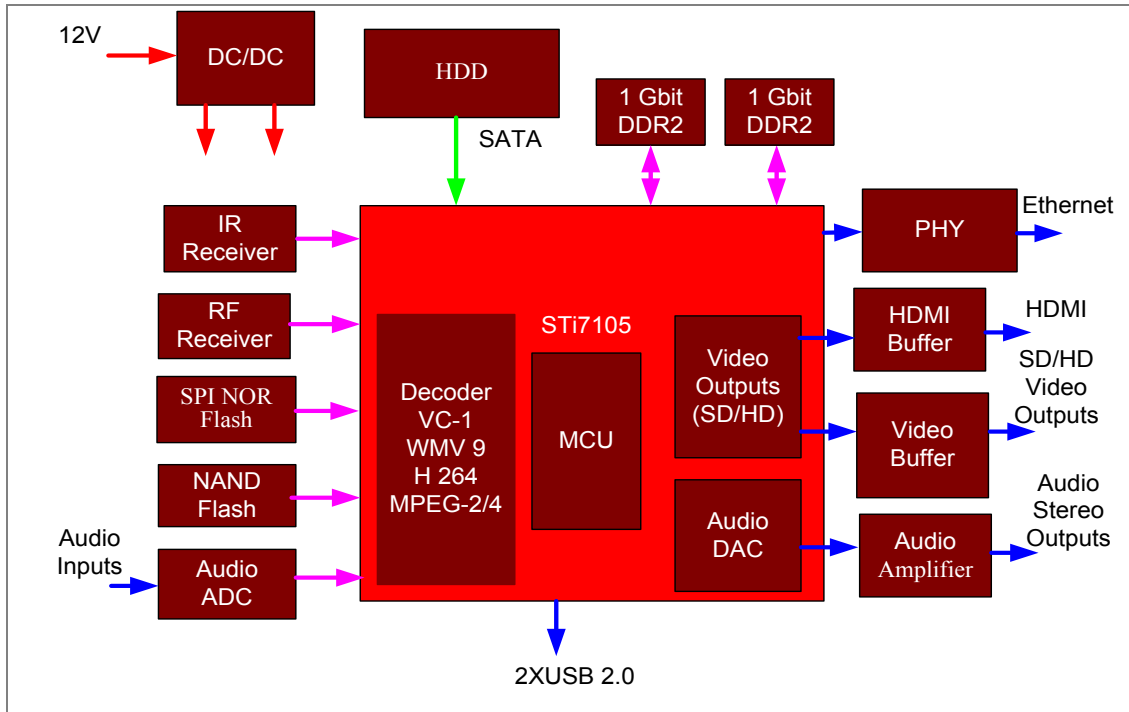
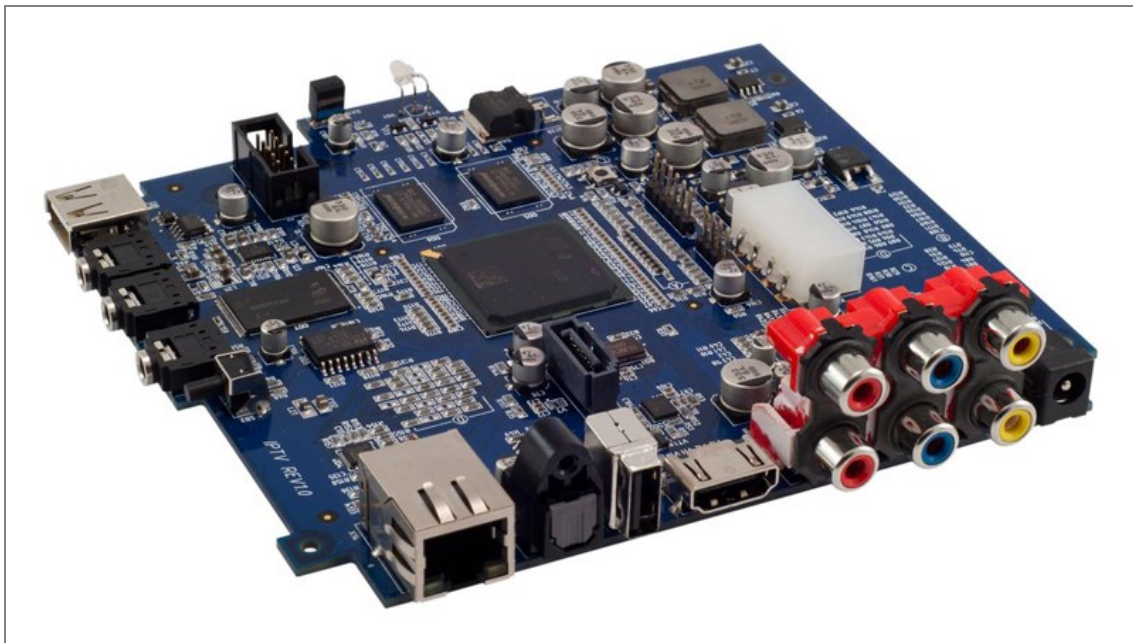


Figure 2. Structural circuit of the device



A list of the key components of the device has been made at the early stages of the project. A bill of materials for set-top box mass production has been drawn up, based on the list of components.

The STi7105 chip by STMicroelectronics has been chosen as a processor for the device. It is fitted with hardware capabilities for decoding video (MPEG-2 ISO/IEC 13818 /MPEG-4 AVC H.264) and sound data (MPEG1, MPEG2, MP3, AC3, ACC). The ST40 core, compatible with Linux, Windows CE and OS21, is responsible for the user functions of the set-top box. The chip has been equipped with a digital-to-analog converter for analog sound, as well as video and HDMI interfaces for high-definition (HD) digital sound and video. The device implements the FMS6363CSX and FMS6143 external microchips for analog video signal filtration and amplification and external operating amplifiers for sound filtration and amplification.

Two DDR2 microchips, with a total storage space of 256 Mb, are used to store the software and data. The set-top box runs from the SPI NOR Flash, while its file system is located on the NAND Flash. The back panel features a USB 2.0 port for connecting an external reading device and a RJ45 Ethernet port for receiving IPTV streaming broadcasts. In addition, it implements digital and analog audio/video outputs. To bring greater convenience for the user, the side panel of the set-top box has been fitted with another USB 2.0 port, two microphone inputs and an external infrared receiver input. The set-top box has a SATA port for connecting a hard disk drive.

In the process of circuit development, the project elements base has been adapted to the manufacturer's needs to cut the BOM cost of the device. Moreover, to further reduce the cost, the printed-circuit board has been implemented with one-sided mounting in the minimal form-factor. DDR2 and differential couples tracing is based on signal integrity and the calculations of the required wave resistance.

2. Embedded Software Design

The following software components have been adapted for testing the functions of the hardware components:

- u-boot
- Linux kernel 2.6.23.17
- Root file system

- Test applications

The following tests have been performed on the set-top box:

- Streaming via RTP and UDP protocols
- Streaming broadcast transmission from the set-top box through the RTP and UDP protocols
- Streaming broadcast reception and transmission through IEEE 802.11 (Wi-Fi module)
- Simultaneous decoding of two programs
- Data recording and playback from a USB storage device and a SATA disk drive

3. Plastic Enclosure Design

A number of enclosure design and style options have been considered for the customer. Based on the option selected, the enclosure design has been elaborated and developed. The designer has implemented the finalized design in a 3D model. The task of providing the required thermal conditions at a compact size and stylish design has been solved in the process of development by fitting the device with a ventilation holes system. Thermal modeling of the device has been performed in special CADs, using board and enclosure models. The structural layout of the device enables HDD replacement without opening and disassembling the enclosure.

Another special development feature is the importance of putting together and connecting a large number of receiver components in a relatively small space. The solution to these problems was reached in the process of accurate 3D modeling and prototype testing.

4. Mass Production and Manufacturing Support

Promwad experts have provided assistance in the production launch of this device in China. The enclosure and printed-circuit boards have been adapted to the technological production requirements and the elements base has been optimized to keep the BOM cost and the time-to-market to a minimum. In addition, the team has provided extensive support in trial samples launch and adjustment as well as in the launch of a pilot batch.

Advantages

- HD video support, 1920x1080p 60Hz
- Control through RF remote control
- Compact enclosure
- Modern design
- Embedded HDD with the possibility of replacement without opening the enclosure
- Minimal number of components in the basic configuration
- Low BOM cost

Technologies	Linux, IPTV
Programming languages	C, C++
Development tools	STWorkbench, gcc
Project management tools	SVN, Dotproject