1 Product Overview

1.1 Introduction

GX3201H is a high performance multi-standard HD decoder SOC chip for TV set-top box. It integrates a 32-bit CK610M CPU, multi-standard video decoder including MPEG2, MPEG4, AVS, AVS plus, H.264, H265, and multi-standard audio decoder, deinterlacer and video post processor, true-color OSD and 2D graphics accelerator, TV encoder, video DACs, HDMI transmitter, USB2.0 Host, Ethernet MAC and PHY, NAND Flash Controller, etc. It guarantees powerful function, excellent performance and low BOM cost.

The channel demodulator is designed to DVB-C, composed of ADC, QAM demodulator, FEC, etc.

The 32-bit CK610M CPU with high performance offers strong ability of software process, which supports a great many advanced applications. The mature real-time operating system and API library can shorten the developing period remarkably.

The multi-standard video decoder supports MPEG2/4, H.264, H265, AVS, AVS plus JPEG/MJPEG HD video decoding. Patented video post-processing unit satisfies deinterlacing and scaling effect.

The processor based audio decoder supports MPEGI/II, MP3, Dolby Digital, Dolby Digital plus, MPEG4 AAC, HE-AAC and DRA decoding.

The PAL/NTSC encoder, one-channel video DAC and integrated HDMI transmitter can be configured as many HD and SD video output mode. Concurrent HD and SD output supported.

True-color OSD and 2D graphics accelerator may supply flowery menu effect, which can meet the requirement of browsers. Meanwhile, owing to the flexible capture engine we can design various multi-picture browser and screen-capture functions.

USB2.0 Host, Ethernet MAC and PHY, NAND Flash Controller may supply advanced applications, such as PVR, VOD.

GX3201H is packaged with LQFP128-EPAD, which helps to reduce the PCB complexity and the BOM cost. Sum up, by the flexible configuration, GX3201H can meet the high performance multi-standard requirement of HD STB market.
1.2 Main Features

Integrates QAM DVB-C demodulator and FEC
Integrates high performance ADC with 10bits, up to 152MHz
High performance 32-bit CK610M CPU integrates 16Kbytes instruction cache and 16Kbytes data cache. The frequency is up to 600MHz. JTAG debug supported
64 PID filtering supported, each of which can mostly use 64 individual data filter channels maximally, and the max filter depth of each channel is 16Byte
The multi-standard video decoder supports JPEG/MJPEG, MPEG2, AVS, AVS plus, MPEG4, H.264, H265 HD or SD advanced video decoding. Error protection and concealment supported
The audio decoder supports MPEGI/II, MP3, Dolby Digital, Dolby Digital plus, MPEG4 AAC, HE-AAC and DRA decoding. The output supports L/R and S/PDIF
5 graphics plane: background color, still image, video, OSD plane, and OSD plane
True-color OSD and 2D graphics accelerator, anti-flicker filter supported
Flexible capture engine, various multi-picture browser and screen-capture functions supported
High performance video deinterlacer and scaler, progressive output supported
All of the PAL and NTSC analog TV standards supported
1 channel video DAC integrated, CVBS output modes supported
HDMI version 1.4, HDCP revision 1.2 and DVI version 0.9 compliant transmitter embedded
2 channel audio DACs integrated, S/N is more than 80dB
2 USB2.0 Host integrated, High-speed and Full-speed devices supported, PVR is supported
A 10M/100M Ethernet MAC and PHY
NAND Flash supported with 32 bit ECC
DDR2/DDR3 SDRAM supported
1 parallel TS input
Conditional access and data broadcast supported
Integrate OTP, support CAS without smart card
Package: LQFP128-EPAD
Typical application: HD set-top box
1.3 Feature List

DVB-C Demodulator

Compliant with DVB-C
256, 128, 64, 32 and 16 QAM demodulation supported
Direct Intermediate Frequency (DIF) / Low Intermediate Frequency (LIF) sampling supported
Roll-Off Factor $0.12 \sim 0.2$
Carrier Acquisition Range is up to $\pm 400$KHz
Variable Symbol Rate: 0.45 ~ 8.5 MBauds
Frequency Spectrum Inversion supported
Integrates Frequency Scan, FD and Decision Loop, provides fast capture and high precision
Blind And DDLMS Algorithm Make Equalizer More Robust
Real-Time Monitor Signal Quality
Variable Depth Deinterleaver

CPU

32bit CK610M CPU with MMU, the frequency up to $60$MHz
16Kbyte data cache, 16Kbyte instruction cache
Interrupts controller and timers
Linux and other mainstream OS supported

Memory

SDRAM: 16 bit width, up to 533MHz, maximal 2GbiDDR2 or DDR3 SDRAM
FLASH: SPI flash, parallel NAND flash
Boot from NAND flash

Transport Stream Processing

TS peak input rate 120Mbps
64 PID filter, each filter corresponding to 64 individual data filter channel maximally, each channel 16Byte depth maximally
Filtering TS, PES, PSI, SI, and so on
Integrated DVB descrambler, TS and PES descrambling supported
Additional TS input interface supports external demodulator
Video Decoder

- H.265 video (HEVC/H.265), BP/MP/HP up to L4.1
- H.264 video (ISO/IEC 14496-10), BP/MP/HP up to L4
- MPEG-4 video (ISO/IEC 14496-2), SP/ASP up to L5
- H.263 P3
- AVS
- AVS plus
- MPEG-2 video (ISO/IEC 13818-2), MP@HL
- MPEG-1 video (ISO/IEC 11172-2)
- Decoding up to 1920×1080p@30fps
- Error detection and concealment
- Hardware accelerated JPEG/MJPEG decoding

Audio Decoder

- MPEG1 I/II, MP3 decoding
- MPEG-4 AAC and AAC plus (HE-AACv1 and v2) decoding
- DRA decoding
- Optionally supports Dolby Digital (AC-3) decoding
- Optionally supports Dolby Digital Plus (DD+) decoding
- Single channel, dual channel, stereo, and joint stereo modes supported
- Sampling rates of 32kHz, 44.1kHz, 48kHz, and MPEG-2 half sampling rates of 16kHz, 22.05kHz, 24kHz supported
- Right justified and left justified output formats supported
- Output word length of 16bits, 18bits, 20bits and 24bits supported
- Mutes and attenuator supported
- Automatic concealment of errors
- 2 channel audio DAC output, S/N is more than 80dB
- One S/PDIF output interface

OSD

- Five display planes: background, still image, video, OSD and OSD
- True-color for background and still image planes supported
- 2bpp, 4bpp, 8bpp CLUT graphics and 16bpp, 32bpp true color graphics, RGB565, RGBA5551, RGBA4444, RGBA8888 formats supported
- Alpha blending and anti-flicker filters supported
2D graphics accelerator supported

**Video Post Processor**

- High performance 3D deinterlacer supported
- Full-range scaler supported
- Letterbox and Pan & Scan modes supported
- 4:3 and 16:9 supported

**Video Interface**

- PAL-B B1 D D1 G H I K K1, PAL-M, PAL-N, PAL-Nc, N5C-M, NTSC-4.43 in TV encoder supported
- One 10-bit DAC outputs
- CVBS output modes supported
- HDMI 1.4 transmitter output delivers an HD video (1080p, 720p, 576p, 480p, etc)
- Encoding of Teletext, close caption, WSS, CGMS and VP

**PVR**

- USB device PVR supported
- Pause, Slow, Fast and Skip supported
- Time shift mode supported
- The program can be saved as TS or private type

**On-chip Peripherals**

- Two USB2.0 host support High-speed and Full-speed devices
- One smart card interfaces
- One 10M/100M Ethernet MAC and PHY
- Two UART with maximum 115200bps
- One NAND Flash interface
- Integrated VCXO, crystal with 27MHz supported
- JTAG debug interface
2 Function Description

![Figure 2-1 GX3201H Architecture diagram](image)

2.1 CPU
The CK610M processor core runs up to 600MHz, which also comprises CPU, memory (16Kbyte instruction cache, 16Kbyte data cache) and JTAG controller for real-time debugging.

2.2 Memory Subsystem
The GX3201H has a DDR2/DDR3-SDRAM interface and a flash interface. The GX3201H’s DDR2/DDR3-SDRAM interface is used for all requirements in unified memory applications, including graphics, video and audio buffers, and so on. It provides 16bits wide DDR2/DDR3-SDRAM which can support up to 533MHz. It supports up to 2Gbit DDR2/DDR3-SDRAM.

2.3 Video Decode and Display
The video decoder gets PES data and reference frames in SDRAM by DMA, and runs decoding,
then transfers the result frame to SDRAM by DMA. The video display module is in charge of the video frame management, deciding which video frame buffer should be displayed.

2.4 Transport Stream Processing

GX3201H supports 1 parallel transport stream input. The demultiplexor performs transport stream descrambling, demultiplexing and data filtering. PES data is transferred by DMA to audio and video buffers in SDRAM. Section data is transferred by DMA buffers in SDRAM for further processing by CPU. DVB transport streams can be handled by the demultiplexor with data rates to 120Mbit/s. PID filtering is to select the audio, video and data packets to be processed. It can also support 64 PID slots.

The demultiplexor can descramble streams using the DVB-CSA cipher. It has a section filter core that filters DVB standard sections using 32*16-byte filters.

2.5 Graphics and Display

VPU (Video Process Unit) is composed of PP (Digital Video Post-Process) unit, OSD (On Screen Display) unit, SOSD (Sub On Screen Display) unit, PIC (Picture unit), CE (Capture Engine) unit, VDE (VBI Date Engine) and MIXER unit.

The video and graphic data are stored in the SDRAM. VPU will get these data by DMA, process them and finally output to Video out module. The CE unit which captures the graphic data from MIXER unit and stores them to SDRAM is different from other unit in VPU module.

The GA module is composed of buffer_ctrl unit, bitblit unit, mix unit, colorfill unit and cmd_ctrl unit.

GA supports the following operations:
- 2D/1D data block copy;
- 2D/1D data block filling;
- 2D/1D data block mix operation;
- 2D/1D data block color conversion;
- 2D/1D data block scale and rotate.

The deinterlace unit performs video deinterlacing and denoising. The functions of this module are configurable; users can turn on/off functions on different applications. The module supports different resolution, from CIF to HD.

2.6 Video Output

The video output converts a 4:4:4 digital video stream into a standard composite baseband PAL/NTSC signals. It supports almost all kinds of composite video baseband standards, including PAL-B/B1/D/D1/G/H/I/K/K1, PAL-M, PAL-N, PAL-Nc, NTSC-M, NTSC-4.43, etc.
2.7 Audio Decode and Display

The audio decoder gets audio PES or PCM data from SDRAM by DMA, and decodes the data, then the PCM audio data will be wrote to the SDRAM again.
The audio player can output PCM data with S/PDIF interface, or the Dolby streams on the S/PDIF interface.
Sampling rates of 32kHz, 44.1kHz, 48kHz, and MPEG-2 half sampling rates of 16kHz, 22.05kHz, 24kHz are supported.

2.8 Internal Peripherals

The GX3201H has many dedicated internal peripherals, including:
- Two USB2.0 hosts which support High-speed and Full-speed devices;
- One smart card interface;
- 10M/100M Ethernet MAC and PHY;
- NAND Flash Interface which supports NAND Flash with ECC;
- Two UART with maximum 115200bps;
- An infrared blaster/decoder interface module;
- An interrupt controller;
- A watchdog controller;
- Integrated VCXO, crystal with 27MHz supported;
- JTAG debug interface;
- HDMI 1.4 supports HDCP 1.2 and DDC.