A Single Chip Video CD with Hi-FI Audio for Consumer Applications

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What is Video CD?

Standard reproduction system for combining full motion pictures together with high quality audio using the Compact Disk format

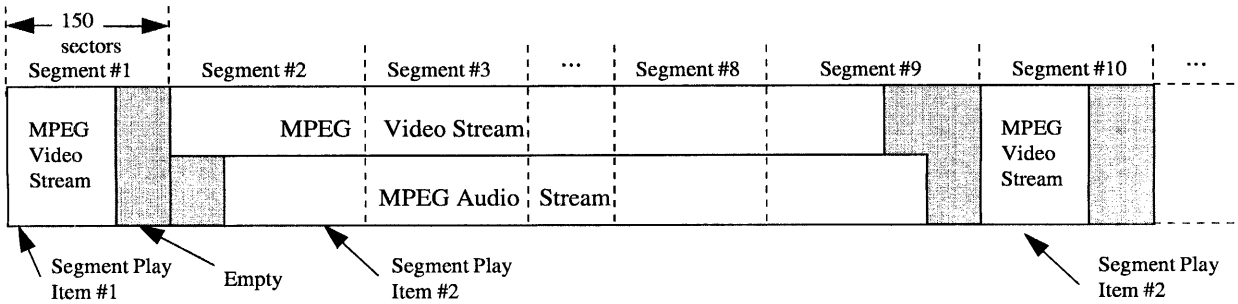
- Based on the CD Bridge format
- Video CD disc can contain more than 70 minutes of data

Video + Audio Compression employs the ISO MPEG1 Standard

- Maximum bitrate = 1,377,600 bits/sec.
- Audio is layer II, sampled at 44.1 KHz

Supported by JVC, Matsushita, Philips, & Sony

- Referred to commonly as the "White Book"



Video CD Applications

Video-CD is suitable for a wide range of Video Products

- Video-CD Players (Karaoke Machines)
- CD-I Players with Digital Video Extension
- Computers equipped with CD-ROM drives & MPEG Decoders
- Modified CD Players with a Digital Output and an Add-On Video-CD Adaptor

Video-CD 1.1 introduced in September, 1993

Video-CD 2.0 introduced in March, 1994

Video-CD 2.0 Feature Extensions

1. Add high resolution (704 x 480 or 704 x 576) still pictures for best quality stills on NTSC or PAL TVs.

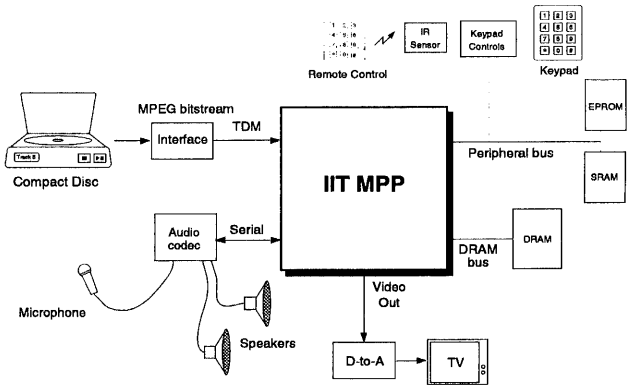
   and

2. Add new audio quality modes:

LOW	128 kBIT/64 kBIT	(stereo/mono)
MIDDLE	192 kBIT/96 kBIT	
HIGH	384 kBIT/192 kBIT	

3. Add new playback control modes

Multimedia Playback Processor (MPP) System



TDM: General Purpose 16 Mbit/sec. serial link

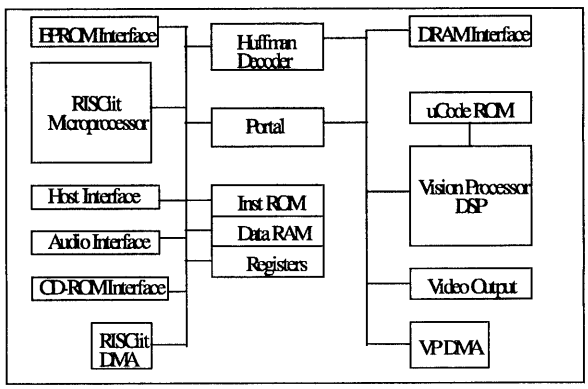
AUDIO: Bidirectional serial port designed for seamless interfacing w/ DACs + ADCs for the transfer of PCM audio data

VIDEO OUT: YUV/RGB output display of frames stored in DRAM

DRAM Iface: Connects to ordinary 70ns PAGE-Mode DRAMs

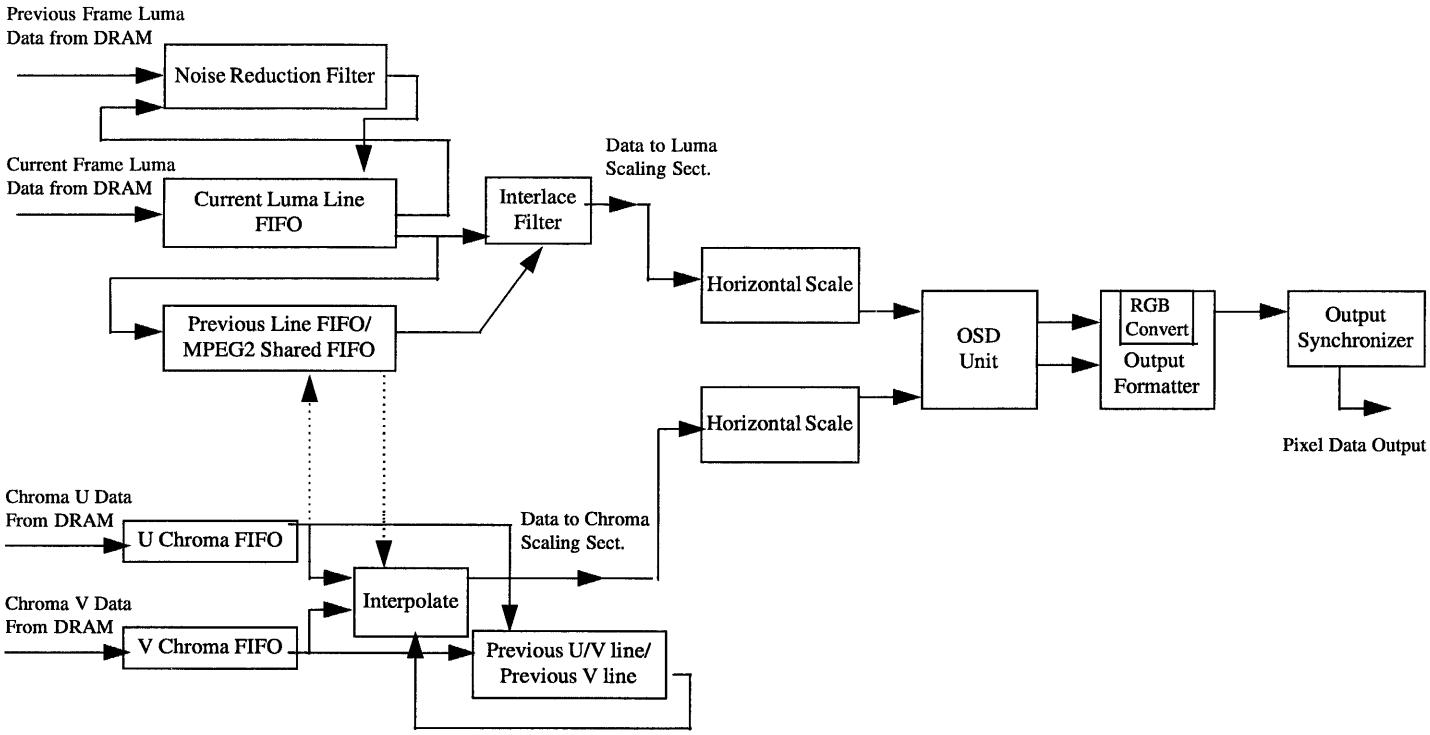
Peripheral Bus: Microprocessor code store (for standalone boot) and interface to auxiliary system slave devices.

MPP Block Diagram



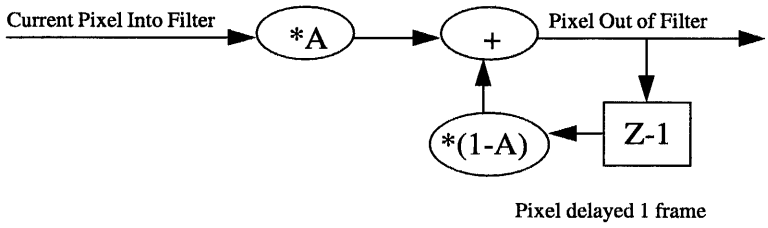
- RISC
  - 40 MIPS 32-BIT RISC
  - On-chip Instruction ROM, Customized Code in external EPROM
  - 10 DMA channels
- VP DSP
  - 80 MHz SIMD machine with 128-BIT ALU, 64-bit MAC
  - Vertical pixel processing
  - On-chip microcode store (ROM/RAM)
- Video Output
  - On-Screen Display (OSD)
  - Decimation + Interpolation Filters for CCIR601/SIF conversion @ 60 frames/sec.
  - Temporal, block edge, + interlacing filters
  - Arbitrary image scaling for PAL/NTSC disc translation

Video Output/Post Processing



Video Post-Processing Components

- Noise Reduction Filter



Pel(i) = A*NewPel(i) + (1-A)*Pel(i-1).
Pel(i) = Pel(i-1) + A*(New Pel(i) + Pel(i-1))
Assume B = (A-1)
Pel(i) = NewPel(i) + B*(NewPel(i)-Pel(i-1))

- Luma Interlacing/Chroma Interpolation

LUMA

DMA Data	Data Out to Scalers Field 1	Data Out to Scalers Field 2
Line 0 _____		
Line1 _____	3/4 Line0 + 1/4 Line1	1/4 Line0 + 3/4 Line1
Line2 _____	3/4 Line1 + 1/4 Line2	1/4 Line1 + 3/4 Line2
Line3 _____	3/4 Line2 + 1/4 Line3	1/4 Line2 + 3/4 Line3
	...	

CHROMA

4:2:0 Data From DRAM

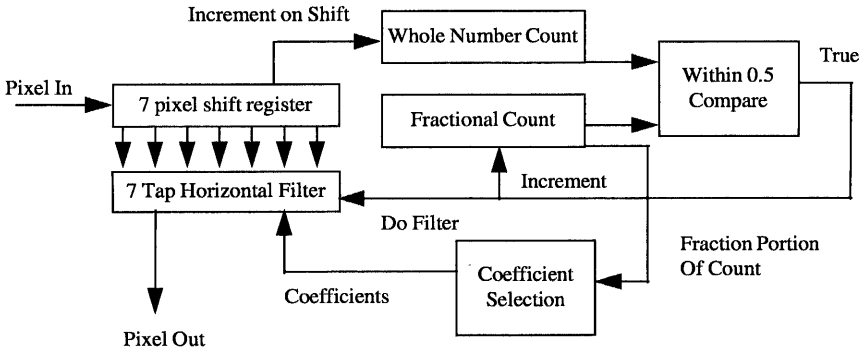
L1	Y0	Y1	Y2	Y3	Y4	...
CH1	U0A	V1A	U2A	V3A	U4A	...
L2	Y0	Y1	Y2	Y3	Y4	...
L3	Y0	Y1	Y2	Y3	Y4	...
CH2	U0B	V1B	U2B	V3B	U4B	...

The interpolated chroma looks like:

L1	Y0	Y1	Y2	Y3	Y4	...
CH1	U0A	V1A	U2A	V3A	U4A	...
L2	Y0	Y1	Y2	Y3	Y4	...
CH2	U01	V11	U21	V21	U41	...
L3	Y0	Y1	Y2	Y3	Y4	...
CH3	U02	V12	U22	V32	U42	...

Video Post-Processing Components

- Horizontal Scaling



- On-Screen Display

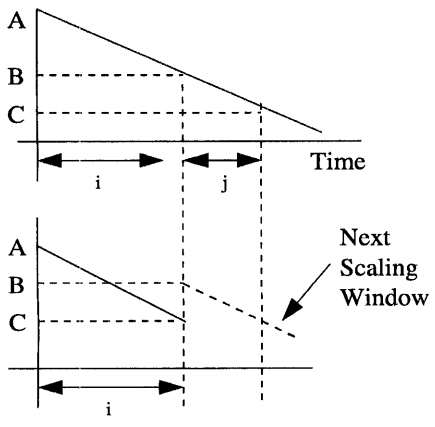
4 Modes of Operation

1. **Bypass**
2. **2 BITS/PIXEL** - LUT for 3 colors, 1 transparent out of a palette of 8192 possible colors (5 BITS Y, 4 BITS U, 4 BITS V). 8 Blending values from 1/8 to 8/8 in LUT for each color
3. **4 BITS/PIXEL** - Same as #2, except palette has 15 colors, 1 transparent
4. **8 BITS/PIXEL** - 4 BITS for LUT (16 colors), 1 BIT transparency, + remaining 3 used for 1/8 to 8/8 mix value

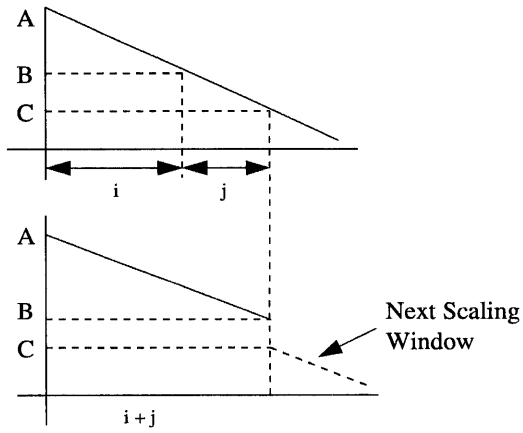
Audio Post-Processing

- Audio Scaling - "KEY UP/KEY DOWN"
  - Use RISC Engine to process 16-BIT Decoded PCM Samples before they are sent to the DAC

KEY UP

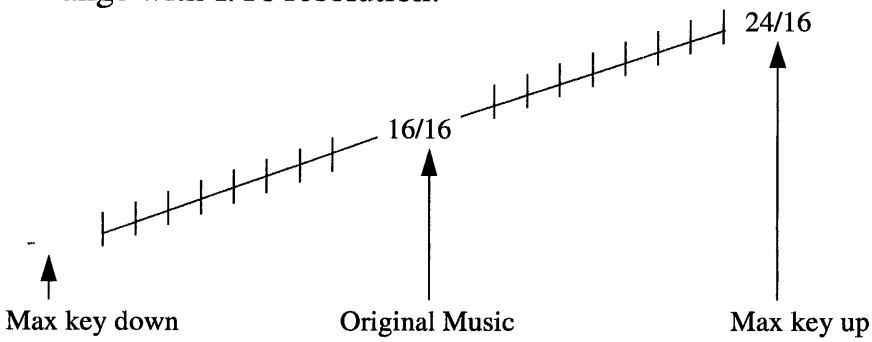


KEY DOWN



RISC-Derived Special Effects

- Overcome Interval Jump with Amplitude Smoothing
  - This method is sufficient for key up/key down in the following range with 1/16 resolution:



- Programmable Reverberation
- MIC Echo
- Surround Sound

Example of Audio Scaling in C

```
#define SCALE_PCM do {                                  \
        idx = beg >> KEY_SHIFT;                         \
        ptmp = (short*) ((long*) last_pcm_in + idx) ;\
          sv   = (long)  (*ptmp) ;       lv = (long)  (*(ptmp+2) ) - sv;\
          dvm = (sv + (((beg & KEY_MASK) * lv) >> KEY_SHIFT));\
        sv   = (long)  (*(ptmp+1)) ;  lv = (long)  (*(ptmp+3)) - sv;\
          dvl  = (sv + (((beg & KEY_MASK) *  lv)  >>  KEY_SHIFT));\
        if  ( cp1  <  FADE_RANGE  )  {\
            dvm = (dvm * cp1)  >>  FADE_SHIFT;\
            dvl   = (dvl * cp1)  >>  FADE_SHIFT;\
         }\
         if  (  cp1  >  (PCM_NUM_PER_BUFFER - FADE_RANGE  ))  {\
            dvm =  (dvm  *  (PCM_NUM_PER_BUFFER - cp1))  >>  FADE_SHIFT;\
            dvl   =  (dvl    *  (PCM_NUM_PER_BUFFER - cp1))  >>  FADE_SHIFT;\
         }\
         CLIPP (dvm) ;  CLIPP (dvl) ;\
         *pout = (dvm  <<  16)  |  (dvl  &  Oxffff) ;  \
} while (0)
```

MPP Technology Overview

Technology:	0.5µm CMOS triple layer metal
Chip Size:	6.98mm x 6.98mm
Transistor Count:	0.9M
Clock Frequency:	40MHz RISC clock, 80MHz DSP + Video
Power Supply:	5V, 3.3V
Power Dissipation:	< 1.5W @ 5V
Package Type:	208 PQFP
Samples:	NOW
Production:	NOW

Digital Video Disc (DVD) Format

- High quality video (MPEG 2 coding) (better than LD)
- Large capacity (5-10 GBytes) - 2 hour movies
- Theatre Quality Audio (multi-channel)
- Multi-function
  - Interactiveness
  - Multi-aspect

MPP functionality will support these requirements

Conclusions

- The MPP's application requires a high degree of integration, excellent video and audio quality, low power, and low overall system cost
- Including an embedded RISC in parallel with a DSP and dedicated hardware can be cost effective
- Video post-processing in hardware

  Audio post-processing in software

  Other system functions are integrated as the RISC MIPS increase:
  - CD Block Decoder functions
  - CD Microcontrol functions
  - Bitstream error suppression/recovery