Enabling Portable, Lower-Power HDMI with Interface IP from MIPS Technologies

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Abstract

System-on-Chip (SoC) designers can now incorporate an HDMI interface in chip designs (launching with 65nm process, more to come), eliminating the need for a separate IC, and delivering significant power-savings and cost-savings. In addition to products for the digital living room, portable consumer electronics constitute the main target applications.

Introduction

Practically anyone who has set up a new digital TV in the past few years is familiar with HDMI, as this still-new form of audio-video connection is becoming ever more ubiquitous. By 2009, it's estimated there will be more than 100 million television sets worldwide offering this connection. Though originally conceived as a connector for relatively large, bulky AC powered home-theater components such as DVD players and cable and satellite-TV set top boxes, increasingly, consumers have portable devices containing content that's best displayed on a TV through an HDMI connector. These applications include digital video camcorders, digital still cameras, cell phone handsets with cameras, MP3/portable media players, and more.

New HDMI 1.3 TX/RX Interface IP (Controller + PHY) from MIPS Technologies Inc. addresses these new, low-power portable applications for HDMI by enabling the System-on-Chip (SoC) designer to incorporate an HDMI interface, eliminating what previously required a separate IC.

What is HDMI?

HDMI stands for High-Definition Multimedia Interface, and it carries video, audio, control signals, and copy protection (DRM) in a single connector.

HDMI is better than the analog connections still prevalent (though being phased out) in today's TVs. These include component video (comprising three separate jacks colored red, green and blue), S-video (a mini-DIN connector), and composite video (a single yellow-colored jack). All analog connections are subject to noise picked up as the cable itself encounters RF and electromagnetic interference, and this problem gets worse as frequencies inside the cable increase, as occurs with high-definition video.

HDMI's digital technology is far less vulnerable to noise, delivering the superior image quality that the HD source is capable of. It also has Hollywood's blessing through a built-in digital rights management (DRM) copy protection system called HDCP, for High-bandwidth Digital Content Protection. Utilizing TMDS (Transition Minimized Differential Signaling) digital communications technology, standard HDMI connectors can carry video with resolutions up to 1080p and with up to eight separate audio channels for 7.1 surround sound, plus a Consumer Electronics Control (CEC) channel providing remote control functions (per the HDMI v.1.3 specification).

For consumers, HDMI offers convenience. A single HDMI connection replaces five separate connections required for component video and stereo audio.

How HDMI is different from other digital video connections

HDMI is the most prevalent digital video interface found on TVs for good reasons. Unlike compressed forms of digital video transmissions, HDMI's uncompressed signal requires a minimum amount of signal processing in the TV itself. So it costs less for the TV manufacturer to implement than systems that might require, for example, MPEG-4 or H.264 decoding. Additionally, by carrying "raw" picture information, the highest-possible picture quality, completely free of any additional artifacts, is assured.

There are competing technologies, most notably DisplayPort, with some similar capabilities. Ultimately, it is the television set manufacturers who decide which interfaces to include in their designs, and right now (and for foreseeable future) they're voting overwhelmingly for HDMI. This should be no surprise, since HDMI founders, including a group of six consumer electronics manufacturers—Hitachi, Sony, Matsushita (Panasonic), Philips, Toshiba, and Thomson—originally created the technology to get past Hollywood's copy protection roadblock in the deployment of digital video technologies. It has support from major studios including Fox, Universal, Warner Bros. and Disney.

HDMI's Smaller Connector Type and Transmitter Applications

The standard "Type A" HDMI connector is physically large, measuring about 14mm wide, and was intended for home video and audio components. These applications include DVD players and recorders, set top boxes for cable-TV, satellite-TV and IPTV, video game consoles (Xbox, PlayStation, Wii), audio/video receivers (tuner-amplifiers), and audio/video processing devices.

In 2006, a smaller "Type C" HDMI connector was introduced to address the needs of portable applications. When developing an HD camcorder, for example, without HDMI, it is almost impossible for a designer to enable the consumer to see the high definition signal without first transferring it to a PC or an intermediate format. Although most camcorders incorporate analog composite or S-video outputs, these only handle standard definition video, not high-def. Digital camcorders have thus become the first adopters of the small HDMI connectors.

Digital still cameras have historically included analog video outputs as well, and similarly, as 5 to 10-Mpixel imaging has become commonplace, it's illogical to squeeze this fine detail through blurry analog connections. Even camera phones—the built-in camera capabilities found on all but the lowest-end cell phone handsets—now commonly incorporate 1.3 and 2-Mpixel image sensors, producing more detail than can be seen over analog video connections, and 5-Mpixel camera phones are imminent.

While the screens on portable media players and portable game players are themselves often limited to less than standard definition—320 x 240 is common—many of these devices are capable of *storing* recordings in high definition. Additionally, music enthusiasts may use HDMI to provide a digital audio connection even when there is no video—to listen to portable MP3 recordings on a stereo system, for example.

HDMI Integrated Circuits (ICs) have been available to designers for several years, and have already gained wide popularity in high definition home theater components. But for portable applications, these ICs are too bulky and power hungry to fit into the smallest devices, such as compact cameras and handsets. Most portable devices as well as many larger CE components are designed as a single "System-on-Chip."

System-on-Chip Technology

The SoC has become the most compact and efficient way to make a wide variety of consumer electronics products. Where a decade or more ago a design engineer would assemble separate integrated circuits on a printed circuit board that interconnected them, considerable space and power savings can be achieved by putting the "guts" of all of these components onto a single piece of silicon. These space and power savings have enabled a wide variety of portable products, including handsets, cameras, and media players that would have simply been impossible using separate ICs.

One of the first decisions an SoC designer makes is which “CMOS technology process node” to design in—meaning, what size will the chip be. The measure of the node, in nanometers (nm) refers to the length of the silicon channel between source and drain terminals in SoC transistors. This keeps getting smaller as technology advances (Moore’s Law). Designing in today’s smallest nodes, such as 45nm, offers smaller size and lower power consumption, but costs more to develop up front. While 130nm and 90nm were common just a few years ago, the 65nm node currently represents the best overall compromise between development costs, size and power consumption for portable application SoCs.

SoC designs utilize processor cores, such as the popular MIPS-Based™ cores, to do the heavy lifting of signal processing, as well as memory, and input/output interfaces such as the HDMI Interface. The HDMI Interface IP consists of two sections: the Controller (processor) and the PHY (physical layer, or the actual connections to the “outside world” of external devices).

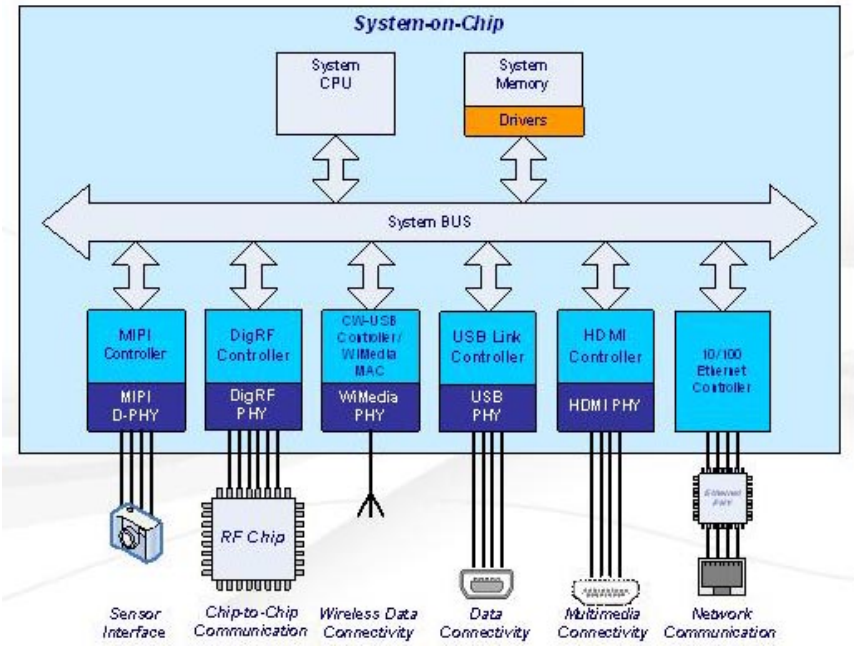

Fig. 1: The HDMI Interface, consisting of the HDMI Controller and HDMI PHY, provides one of several connectivity options between the SoC and other devices.

HDMI IP for SoCs

SoC designers do not start from scratch for each new product. This is where the SoC IP supplier comes in—delivering to the SoC designer the intellectual property (IP) required to add modular capabilities, such as computational processing, memory, input/output control, etc., to the design.

Advantages of HDMI Interface IP for SoCs, compared with using separate ICs, include cost savings, power savings, and space savings. The space savings are significant. HDMI Interface IP makes it possible to add HDMI to many products, such as handsets, where it would have previously been impossible.

Many IP providers are experienced in either digital or analog IP. The HDMI Interface requires expertise in both, giving MIPS Technologies a distinct competitive advantage.

MIPS' recent acquisition of Chipidea brings proven experience in LVDS (low voltage differential signaling), the underlying analog technology used in HDMI signals.

Distinguishing Features of MIPS' Implementation

As a pure IP company, MIPS is intimately familiar with the needs of the SoC designer, and has created HDMI transmitter and receiver IP specifically with SoC designers in mind. This contrasts with some competing IP suppliers who might just take existing designs for their own chips and re-purpose them as IP.

In addition to the "standard" HDMI interface that provides identical functionality to a separate HDMI integrated circuit (or the IP currently available from competing vendors), MIPS Technologies' HDMI Interface IP offers numerous customizations and optional features to aid SoC designers, including:

- Direct system bus slave interface via APB, AHB or OCP
- Direct Memory Access (DMA) audio via AHB or OCP
- Multiple audio in/out options including I2C, SPDIF, One-Bit-Audio, and Parallel Audio
- Color space conversion (RGB to/from YCbCr 4:4:4 and 4:2:2)
- Video in/out in all CEA-861-D video modes (up to 1080p @ 60Hz)
- Optional HDCP encryption/decryption with external ROM interface for key storage

Advantages for SoC Design Engineers

The flexibility for SoC designers to include or exclude HDMI features as needed, versus incorporating the entire full specification, results in significant cost (both manufacturing and licensing), power and space savings.

A digital still camera SoC doesn't need to include HDCP copy protection for Hollywood movies, for example. It's advantageous to eliminate HDCP, resulting in fewer gates, plus savings in license fees.

Power savings can be significant too. For digital still camera applications, the HDMI Transmitter can consume as little as 55mW, versus an already impressively low 145mW for the full-featured HDMI Transmitter in 65nm.

Large savings in area and power can also be realized through direct system bus access for video and audio. Conventional HDMI chips, and available IP until now, required conversion to I2S and SPDIF via translators, and these conversions (essentially serializing parallel data on the transmit side, and reversing that to receive) consume area and power.

MIPS Technologies' HDMI IP eliminates this inefficiency, delivering system bus flexibility with internal register access and direct memory access.

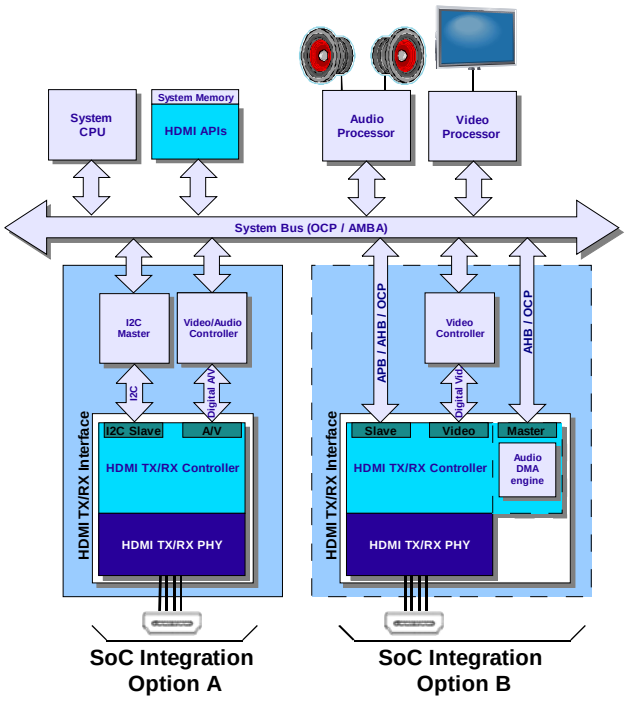

Fig. 2: MIPS HDMI Interfaces. Option A is a "standard" HDMI Interface, while Option B provides easier integration, power and cost savings, and additional customizations.

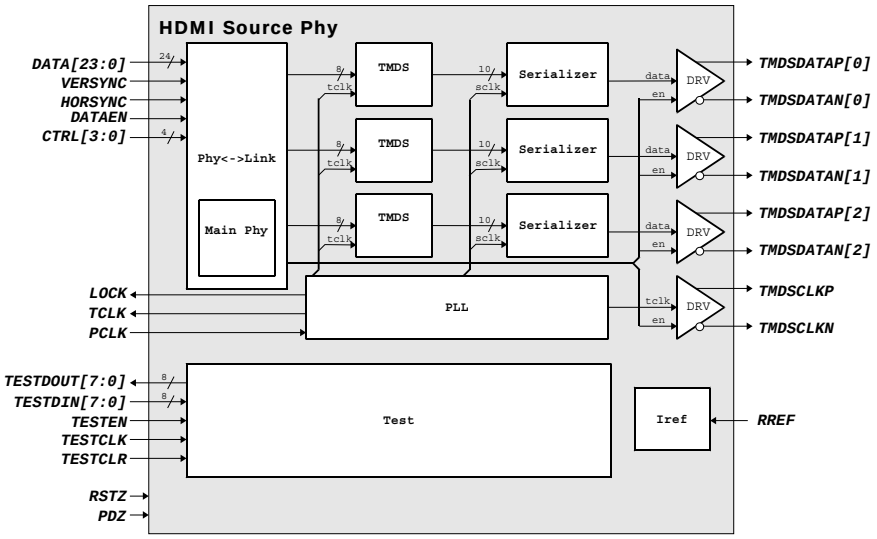

Fig. 3: HDMI Transmitter PHY Layer provides connections to external devices.

Roadmap for HDMI IP

MIPS Technologies is dedicated to supplying HDMI Interface IP for the widest range of products and utilizing all available technology nodes favored by today's SoC designers.

MIPS' introductory HDMI product is the HDMI Transmitter at 65nm, which should satisfy the largest swath of designers of cameras and many other portable applications. This will be followed by HDMI Receiver IP. Next on the roadmap is HDMI Transmitter and Receiver IP for the 45nm node, which will enable even lower power and smaller area implementations for the handset market. As the technology roadmap continues to unfold, MIPS Technologies is committed to supplying SoC designers with the IP they need to stay on the cutting edge.

Conclusion

By adding a low-power, low-area HDMI Interface to their SoC designs for portable applications, designers can "liberate" the high definition picture quality already there, but which until now has not been viewable on a TV. MIPS Technologies, Inc. is a 100% pure IP company that has led the industry in processor cores and analog IP (via Chipidea). Working closely with SoC designers, delivering the support and tools they need, MIPS Technologies' HDMI IP can streamline the process of adding HDMI capability to practically any portable audio, video, or imaging device.

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