

# HDMI Transmitter/Receiver Support on TMS320DM6467

Paul Yin

### **ABSTRACT**

This application report describes how to equip the DM6467 device with transmit/receive capabilities via high-definition multimedia interface (HDMI). A general description is provided for all the DM6467 internal peripherals which are required in HDMI transmitting/receiving, as well as the Sil9134 HDMI transmitter and the Sil9135 HDMI receiver. The block diagrams for both the transmit side logic and the receive logic are provided to illustrate how to connect the DM6467 device to the Sil9134 and the Sil9135 devices.

This document does not explain the actual schematics for the block diagram.

This document does not explain the software programming involved to configure DM6467, Sil9134, or Sil9135.

Contents			
1	Introduction	•	
2	HDMI Transmitter Logic	(	
3	HDMI Receiver Logic	!	
4	References	6	
	List of Figures		
1	Transmit Logic Block Diagram	(	
2	Receive Logic Block Diagram	į	

# 1 Introduction

# 1.1 Introduction to DM6467 DMSoC (VPIF, McASP, GPIO, I2C)

There are four DM6467 internal peripherals involved in implementing the HDMI applications discussed in this application note. These peripherals are: video port interface (VPIF), multichannel audio serial port (McASP), general-purpose input/output (GPIO), and inter-integrated circuit (I2C). The main features of each peripheral are discussed below.

The DM6467 VPIF is a receiver and transmitter of video data. It has both receiver and transmitter logic. The receiver is capable of receiving dual-channel 8-bit BT.656 and single-channel 16-bit BT.1120 (720p, 1080i, and 1080-30p), as well as 8/10/12-bit raw data. The transmitter is capable of transmitting dual-channel 8-bit BT.656 and single-channel 16-bit BT.1120 (720p, 1080i, and 1080-30p). For more details on the functionality of VPIF, see the *TMS320DM646x DMSoC Video Port Interface (VPIF) User's Guide* (SPRUER9).

C64x is a trademark of Texas Instruments.

All other trademarks are the property of their respective owners.



Introduction www.ti.com

The DM6467 McASP is a receiver and transmitter of audio data. This peripheral supports: transmitting/receiving in time-division multiplexed (TDM), inter-integrated sound (I2S) mode, and transmitting in digital audio interface transmit (DIT) mode. The McASP consists of transmit and receive interfaces that may operate synchronized, or completely independently with separate master clocks, bit clocks, frame syncs, and different transmit modes with different bit-stream formats. There are two instances of the McASP on this device. The McASP1 module is not used in the HDMI applications due to its integration limitations. The McASP0 module includes four serializers that can be individually enabled to either transmit or receive in all different modes (except receiving in DIT mode). For more details on the functionality of McASP, see the TMS320DM646x DMSoC Multichannel Audio Serial Port (McASP) User's Guide (SPRUER1).

The DM6467 GPIO is a group of dedicated general-purpose pins that may be configured as either inputs or outputs. When configured as an output, you can write to an internal register to control the state driven on the output pin. When configured as an input, you can detect the state of the input by reading the state of an internal register. The GPIO peripheral is accessible via the ARM926 CPU as well as the C64x<sup>™</sup> CPU. All GPIO signals can be used as interrupt sources with configurable edge detection when configured as an input, and in case external onboard components need immediate CPU attention. For more details on the functionality of GPIO, see the *TMS320DM646x DMSoC General-Purpose Input/Output (GPIO) User's Guide* (SPRUEQ8).

The DM6467 I2C is a dedicated peripheral providing an interface between the TMS320DM6467 DMSoC and other devices that are compliant with the I2C-bus specification and connected by way of an I2C-bus. External components that are attached to this 2-wire serial bus can transmit and receive data that is 2-bits to 8-bits wide to and from the DMSoC through I2C. It can be configured to function in either slave-mode or master-mode. In the master-mode, it can be used to control external onboard components. For more details on the functionality of I2C, see the *TMS320DM646x DMSoC Inter-Integrated Circuit (I2C) Module User's Guide* (SPRUER0).

## 1.2 Introduction to Sil9134 HDMI Transmitter

The Sil9134 HDMI deep color transmitter is HDMI1.3, high-bandwidth digital content protection (HDCP) 1.2, and digital video interface (DVI) 1.0 compliant. Some of the main features of Sil9134 are introduced below. For more details on the functionality, visit <a href="http://www.siliconimage.com">http://www.siliconimage.com</a>.

- Integrated transition minimized differential signaling (TMD) core operating between 25 225 MHz and resolution up to 1080P
- Flexible video interface support
  - 24/30/36-bit RGB/YCbCr 4:4:4
  - 16/20/24-bit YCbCr 4:2:2
  - 8/10/12-bit YCbCr 4:2:2 (BT.656)
  - 12/15/18-bit dual-edge clocking input
  - BTA-T1004 video input
- Flexible video format conversion
- Flexible digital audio interface support
  - High bit rate compressed DTS HD and Dolby True HD audio
  - Dedicated 4-port (8-channel) I2S input
  - Dedicated 4-port (8-channel) DSD input for super audio CD (SACD)
  - Dedicated 1-port Sony/Philips digital interconnect format (SPDIF) input
  - IEC60958 or IEC61937 compatible
- Master I2C interface for DDC connection and Slave I2C interface for control from external processor
- Integrated HDCP encryption engine for transmitting protected audio and video content
- Monitor detection supported through hot plug and receiver detection
- Programmable data enable generator and sync extraction

www.ti.com HDMI Transmitter Logic

#### 1.3 Introduction to Sil9135 HDMI Receiver

The Sil9135 HDMI receiver with enhanced audio and deep color outputs is HDMI1.3, HDCP 1.1, and DVI 1.0 compliant. Some of the main features of Sil9135 are introduced below. For more details on the functionality, visit http://www.siliconimage.com.

- Integrated TMDs core operating between 25 225 MHz and resolution up to 1080P
- Flexible video interface support
  - 36-bit RGB/YCbCr 4:4:4
  - 16/20/24-bit YCbCr 4:2:2
  - 8/10/12-bit YCbCr 4:2:2 (BT.656)
  - 12/15/18-bit dual-edge clocking output
- Flexible video format conversion
- Flexible digital audio interface support
  - High bit rate compressed DTS HD and Dolby True HD audio
  - Shared 4-port (8-channel) I2S input
  - Shared 3-port (6-channel) DSD input for SACD
  - Shared 1-port SPDIF input
  - IEC60958 or IEC61937 compatible
- Slave I2C interface for DDC connection and Slave I2C interface for control from external processor
- Integrated HDCP encryption engine for receiving protected audio and video content

#### 2 **HDMI Transmitter Logic**

The transmitter side logic block diagram is detailed in Figure 1. There are three main blocks in this diagram: the DM6467 evaluation module (EVM) (DM6467 DMSoC), the Sil9134 deep color transmitter, and a generic HDMI connector.

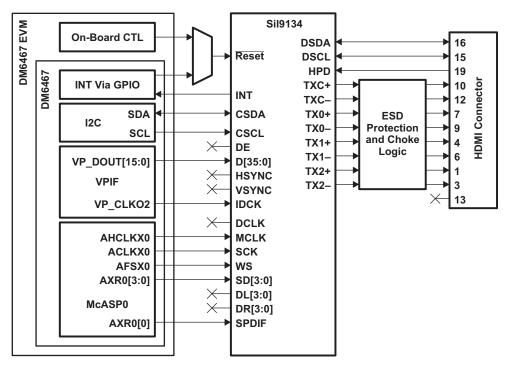


Figure 1. Transmit Logic Block Diagram



HDMI Transmitter Logic www.ti.com

- Signal connection between DM6467 EVM (DM6467 DMSoC) and Sil9134
  - Audio
    - 4-port I2S: AHCLKX0 → MCLK, ACLKX0 → SCK, AFSX0 → WS, and AXR0[3:0] → SD[3:0]
    - 1-port SPDIF: AHCLKX0 → MCLK and AXR0[0] → SPDIF
    - 4-port DSD (not supported by DM6467): DCLK, DL[3:0], and DR[3:0] need to be properly terminated
  - Video
    - CLK: VP\_CLKO2 → IDCK
    - Data
      - Y/C 4:2:2: (Y) VP\_DOUT[7:0]  $\rightarrow$  D[23:16], (C) VP\_DOUT[15:8]  $\rightarrow$  D[35:28]
      - Y/C 4:2:2 muxed: (Y/C) VP\_DOUT[15:8] → D[23:16], D[35:28] not connected
      - VSYNC, HSYNC, DE (not supported by DM6467): VSYNC, HSYNC, and DE need to be properly terminated
  - I2C Control (DM6467 Master, Sil9134 Slave)
    - CLK: SCL → CSCL
    - Data: SDA ↔ CSDA
  - INT (interrupt signal from Sil9134 to DM6467 via GPIO)
- Signal connection between Sil9134 and generic HDMI connector
  - Three transition minimized differential signaling (TMDS) pair data channel
    - TX0+  $\rightarrow$  Pin 7, TX0-  $\rightarrow$  Pin 9, TX1+  $\rightarrow$  Pin 4, TX1-  $\rightarrow$  Pin 6, TX2+  $\rightarrow$  Pin 1, TX2-  $\rightarrow$  Pin 3
  - One TMDS pair clock channel
    - TXC+  $\rightarrow$  Pin 10, TXC-  $\rightarrow$  Pin 12
  - I2C control connection (Sil9134 Master)
    - DSDA ↔ Pin 16, DSCL ↔ Pin 15
  - Hot Plug Detect (HPD)
    - HPD ← Pin 19
  - Consumer Electronics Control (CEC) currently unsupported
    - Pin 13 needs to be properly terminated
- Additional connection considerations
  - Optional electrostatic discharge (ESD) protection and choke logic support
  - On-board logic or DM6467 GPIO controlled Sil9134 RESET signal
  - Sil9134 signals that need to be properly terminated: CI2CA, EXT\_SWING, power, and ground signals

To summarize, the following HDMI audio and video output modes are supported in this application note:

- · Audio output modes
  - Up to 7.1 (4-port I2S)
  - 1-port SPDIF
- Video output modes
  - BT.656
  - BT.1120 (720p, 1080i, and 1080-30p)



www.ti.com HDMI Receiver Logic

# 3 HDMI Receiver Logic

The receiver side logic block diagram is detailed in Figure 2. There are three main blocks in this diagram: the DM6467 EVM (DM6467 DMSoC), the Sil9135 receiver, and two generic HDMI connectors.

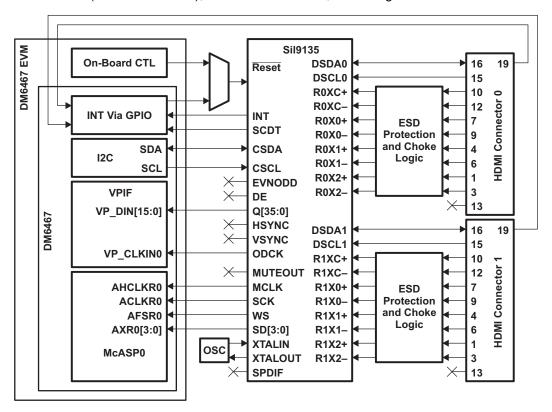


Figure 2. Receive Logic Block Diagram

- Signal connection between DM6467 EVM (DM6467 DMSoC) and Sil9135
  - Audio
    - 4-port I2S: AHCLKR0 ← MCLK, ACLKR0 ← SCK, AFSR0 ← WS, and AXR0[3:0] ← SD[3:0]
    - MUTEOUT (not supported by DM6467): MUTEOUT needs to be properly terminated
  - Video
    - CLK: VP\_CLKIN0 ← ODCK
    - Data
      - Y/C 4:2:2: (Y) VP\_DIN[7:0] ← D[23:16], (C) VP\_DIN[15:8] ← D[35:28]
      - Y/C 4:2:2 muxed: (Y/C) VP\_DIN[15:8] ← D[23:16], D[35:28] not connected
      - VSYNC, HSYNC, DE, EVNODD (not supported by DM6467): VSYNC, HSYNC, DE, and EVNODD need to be properly terminated
  - I2C Control (DM6467 Master, Sil9135 Slave)
    - CLK: SCL → CSCL
    - Data: SDA ↔ CSDA
  - INT (interrupt signal from Sil9135 to DM6467 via GPIO)
  - SCDT (active HDMI video indicator from Sil9135 to DM6467 via GPIO)



References www.ti.com

- Signal connection between Sil9135 and generic HDMI connectors
  - Three transition minimized differential signaling (TMDS) pair data channel
    - To connector 0: R0X0+  $\leftarrow$  Pin 7, R0X0-  $\leftarrow$  Pin 9, R0X1+  $\leftarrow$  Pin 4, R0X1-  $\leftarrow$  Pin 6, R0X2+  $\leftarrow$  Pin 1, R0X2-  $\leftarrow$  Pin 3
    - To connector 1: R1X0+ ← Pin 7, R1X0- ← Pin 9, R1X1+ ← Pin 4, R1X1- ← Pin 6, R1X2+ ← Pin 1, R1X2- ← Pin 3
  - One TMDS pair clock channel
    - To connector 0: R0C+ ← Pin 10, R0C- ← Pin 12
    - To connector 1: R1C+ ← Pin 10, R1C- ← Pin 12
  - I2C control connection (Sil9135 Slave)
    - To connector 0: DSDA0 ↔ Pin 16, DSCL0 ← Pin 15
    - To connector 1: DSDA1 ↔ Pin 16, DSCL1 ← Pin 15
  - Consumer electronics control (CEC) currently unsupported
    - Pin 13 on both connectors need to be properly terminated
- Additional connection considerations
  - Optional ESD protection and choke logic support
  - External oscillator connected between XTALIN and XTALOUT for Sil9135
  - On-board logic or DM6467 GPIO controlled Sil9135 RESET signal
  - Sil9135 signals that need to be properly terminated: CI2CA, R0PWR5V, R1PWR5V, power, and ground signals
  - Hot Plug Detect (HPD) signal from both HDMI connectors
    - Pin 19 on both connectors are fed directly from to DM6467 via GPIO

To summarize, the following HDMI audio and video input modes are supported in this application note:

- Audio input modes
  - Up to 7.1 (4-port I2S)
- Video input modes
  - BT.656
  - BT.1120 (720p, 1080i, and 1080-30p)

### 4 References

- TMS320DM646x DMSoC Multichannel Audio Serial Port (McASP) User's Guide (SPRUER1)
- TMS320DM646x DMSoC Video Port Interface (VPIF) User's Guide (SPRUER9)
- TMS320DM646x DMSoC General-Purpose Input/Output (GPIO) User's Guide (SPRUEQ8)
- TMS320DM646x DMSoC Inter-Integrated Circuit (I2C) Module User's Guide (SPRUERO)
- Sil9134 HDMI Deep Color Transmitter Data Sheet (http://www.siliconimage.com/products/product.aspx?id=102)
- Sil9135 HDMI Receiver with Enhanced Audio and Deep Color Outputs Data Sheet (<a href="http://www.siliconimage.com/products/product.aspx?id=109">http://www.siliconimage.com/products/product.aspx?id=109</a>)

## **IMPORTANT NOTICE**

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

#### **Products Amplifiers** amplifier.ti.com Data Converters dataconverter.ti.com DSP dsp.ti.com Clocks and Timers www.ti.com/clocks Interface interface.ti.com Logic logic.ti.com Power Mgmt power.ti.com Microcontrollers microcontroller.ti.com www.ti-rfid.com RF/IF and ZigBee® Solutions www.ti.com/lprf

Applications	
Audio	www.ti.com/audio
Automotive	www.ti.com/automotive
Broadband	www.ti.com/broadband
Digital Control	www.ti.com/digitalcontrol
Medical	www.ti.com/medical
Military	www.ti.com/military
Optical Networking	www.ti.com/opticalnetwork
Security	www.ti.com/security
Telephony	www.ti.com/telephony
Video & Imaging	www.ti.com/video
Wireless	www.ti.com/wireless

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265 Copyright © 2008, Texas Instruments Incorporated