Application Note

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Video Input/Output Demonstration for Trenz TE0701-05, TE0720-02-1CF, TE0720-02-1QF, TE0720-02-2IF and Avnet HDMI Input/Output FMC Module

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Revision history

Rev.	Date	Author	Description
0	26.08.2015	L. Kohout	Initial version
1			
2			

Contents

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1 Introduction

This document describes a video interfacing of Trenz TE0701-05 carrier board [1] with TE0720-02-1CF, TE0720-02-1QF or TE0720-02-2IF FPGA modules (System on Module SoM, [2]) and Avnet HDMI Input/Output FMC Module (FMC IMAGEON) [3]. Trenz SoMs are compatible with EMC2-DP carrier [4] currently developed by Sundance.

2 Description

This application note describes four different demonstrators, each is precompiled for three SoMs (TE0720-02-1CF, TE0720-02-1QF and TE0720-02-2IF). Xilinx Vivado 2014.4 has been used as the design tool.

2.1 HDMIO

HDMIO demo shows how to interface TE0701-05 carrier board HDMI output. It requires a monitor capable of displaying Full HD resolution at 60 frames per second (1080p60); this demo works with fixed video signal 1920x1080p60 (pixel clock is 148.5 MHz). The output image is generated by test pattern generator TPG and it can be changed during the demo runtime. This demo can run without FMC IMAGEON expansion card.

2.2 IM-HDMIO

IM-HDMIO is almost the same as the HDMIO demo described in Section 2.1, but the video signal from TPG is routed through FMC IMAGEON HDMI output. The demo allows changing video resolution during the runtime thank to programmable clock generator on the FMC IMAGEON expansion board. Supported resolutions are presented in Table 1.

2.3 IM-HDMII-HDMIO

IM-HDMII-HDMIO is a video pass through demo. Video signal originates from FMC IMAGEON HDMI input then it is stored in the video frame buffer. After that it is read from the frame buffer and drives to FMC IMAGEON HDMI output. Table 2 summarizes supported input video signal resolutions as they are presented by EDID to the input video signal source (PC graphic card). Output resolution can be changed at the runtime as well, supported resolutions are presented in Table 1. If the resolution of the input video signal is less than the output resolution, it will be displayed the input video signal plus black margin to fill the required output resolution. In case the resolution of the input video signal is greater than the output resolution is required, the output will be created by cropping of the input video signal. This behavior is shown in Figure 1.

Table 1: Supported resolutions on FMC IMAGEON HDMI output.

Resolution	Frame rate	Pixel clock [MHz]
1920x1080	60	148.50
1920x1200	50	128.44
1600x1200	50	135.00
1680x1050	60	119.23
1280x1024	60	108.00
1028x720	60	74.25
1024x768	60	65.00
800x600	60	40.00
640x480	60	25.19
600x800	60	40.00

Table 2: FMC IMAGEON HDMI Input EDID - supported input resolutions.

Resolution	Frame rate
1920x1080	60
1680x1050	60
1600x1200	50
1440x900	60
1366x768	60
1280x1024	60
1280x960	60
1280x800	60
1280x720	60
1152x864	60
1152x720	60
1024x768	60
800x600	60
800x480	60
720x576	60
720x480	60
640x480	60

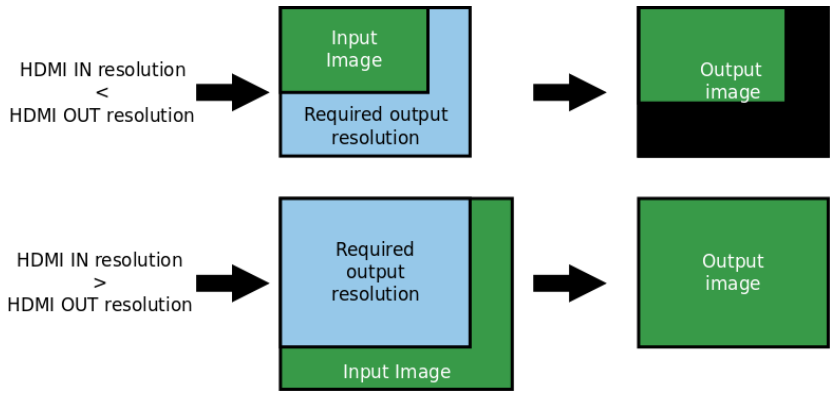

Figure 1: Behavior of the IM-HDMII-HDMIO demo when the input resolution is not the same as the output resolution.

2.4 IM-VITA-HDMIO

IM-VITA-HDMIO demonstrates interfacing Vita 2000 image sensor [5]. The sensor is connected through LCEDI connector on the FMC IMAGEON expansion card. It provides Full HD (1920x1080) video signal at 60 frames per second. This video signal is stored in the video frame buffer, after that it read from the buffer and displayed on the monitor via FMC IMAGEON HDMI output.

3 Required HW resources

The list bellow summarizes required HW components to run the demo:

- Trenz TE0701-05 carrier board [1], Figure 2.
- Trenz, TE0720-02-1CF, TE0720-02-1QF or TE0720-02-2IF SoM [2], Figure 3.
- Avnet HDMI Input/Output FMC Module (FMC IMAGEON) [3], Figure 4.
- Avnet Vita 2000 image sensor [5],

Complete demo kit can be seen in Figure 6.

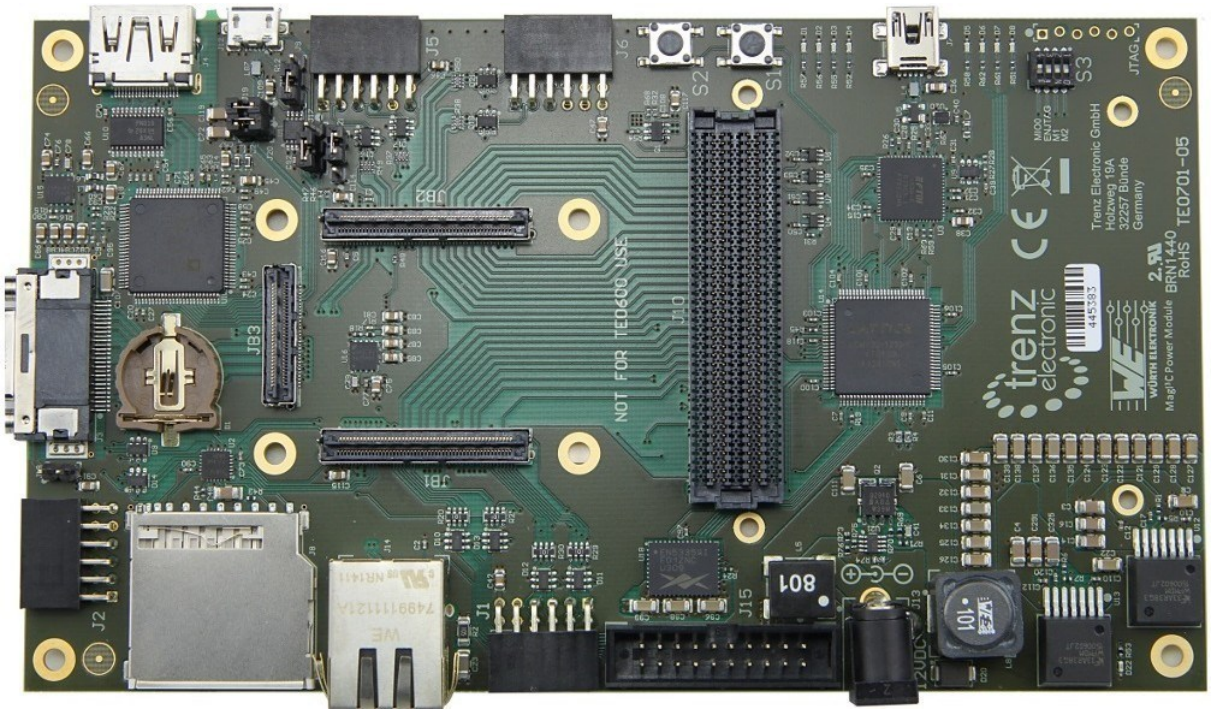

Figure 2: Trenz TE0701-05 carrier board [1].

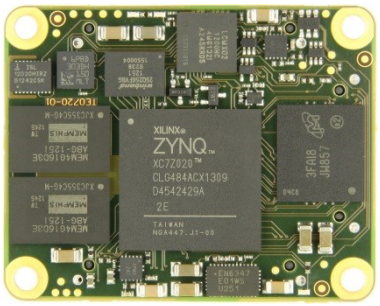

Figure 3: Trenz TE0720-02-XXX SoM [2]

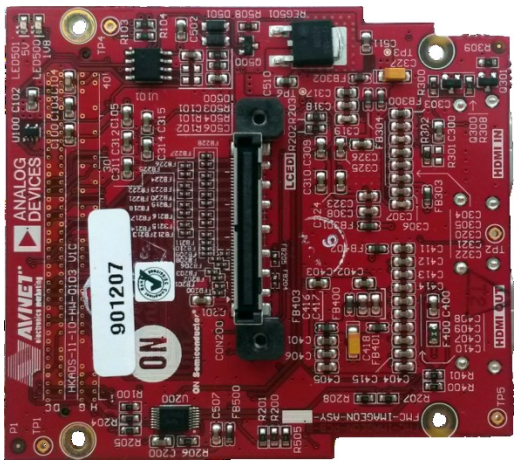

Figure 4: Avnet HDMI Input/Output FMC Module (FMC IMAGEON) [3]

Figure 5: Avnet Vita 2000 image sensor [5].

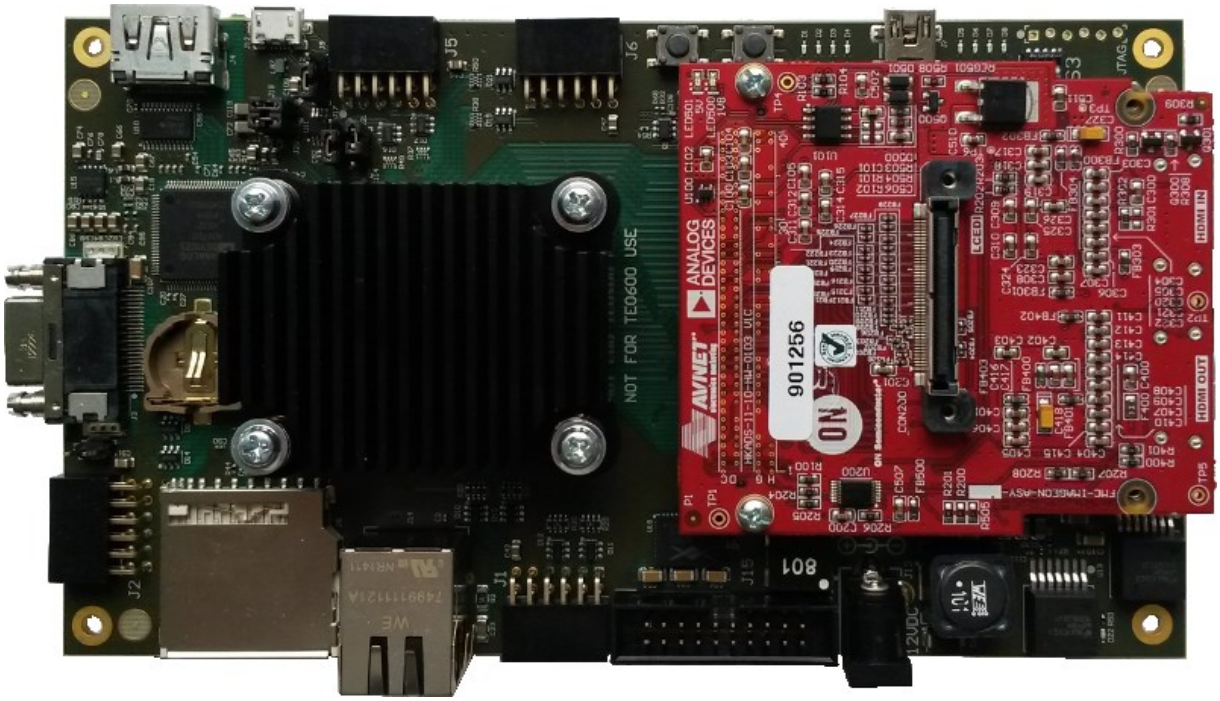

Figure 6: Demonstrator kit - TE0701-05 + TE0720-02-XX SoM + FMC IMAGEON.

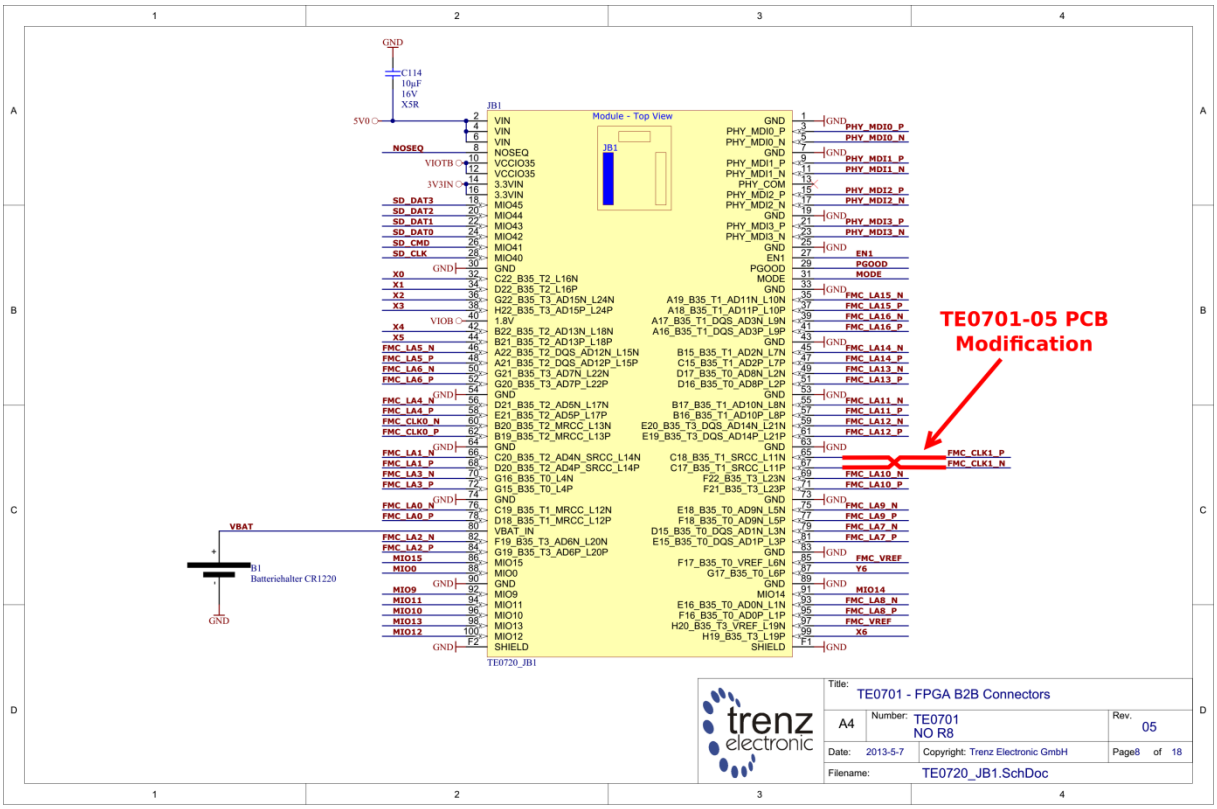

Figure 7: TE0701-05 carrier board modification.

4 TE0701-05 Modification and Setup

Before installing SoM on the carrier board TE0701-05 it is necessary to modify PCB connection. The modification and carrier board setup is described in the list below.

1. To use FMC IMAGEON expansion card FMC_CLK1_P and FMC_CLK1_N signals must be swapped on TE0701-05 carrier board. The modification can be done near JB1 connector at the place where both signals are wired on the PCB surface. The modification must be done before installation of the SoM, since the place is located beneath the SoM when installed. Figure 7 shows new wiring goal, J10B pin G2 must be connected to JB1 pin 67, J10B pin G3 must be connected to JB1 pin 65. As **HDMIO** demo does not use FMC IMAGEON card, this point is not necessary to do in this particular case.
2. Power the carrier board on.
3. Flash the carrier board CPLD with modified firmware, see Package Content Section 6, firmware file *CC701_simple_CC701_10_mod.jed*. The operation may be done also with SoM already in place as well as FMC extension board). Flashing instruction can be found in Trenz Wiki [4]. Quick guide:
    a. Use Lattice Diamond software for flashing the CPLD firmware.
    b. DIP switch S3 labeled "ENJTAG" must be switched to OFF position.
    c. Use Lattice Diamond software and *CC701_simple_CC701_10_mod.jed* file for flash programming.

    NOTE: modified CPLD firmware bypasses JTAG chain around FMC and allows using DIP switches S3 to set VADJ directly. It also asserts PG_C2M FMC signal high after power on automatically. This removes a need to setup I2C chain and do it by GPIO register in CPLD.

4. Set S3 ENJTAG switch back to ON position after flashing CPLD.
5. Set VADJ to 2.5 V with S3 dip switch, set position M1 to OFF and position M2 to ON.
6. Plug SoM and FMC IMAGEON in.

5 Demonstrator Startup

1. Connect HDMI input/output and Vita 2000 sensor according to selected demo:
   a. **HDMIO** – connect TE0701-05 HDMI output to monitor capable of displaying Full HD resolution at 60 frames per second (1080p60).
   b. **IM-HDMIO** – connect FMC IMAGEON HDMI output to monitor capable of displaying Full HD resolution at 60 frames per second (1080p60).
   c. **IM-HDMII-HDMIO** – connect FMC IMAGEON HDMI output to monitor capable of displaying Full HD resolution at 60 frames per second (1080p60). Connect valid video signal to FMC IMAGEON HDMI input, Table 1 in Section 2.3 summarizes all resolutions presented by EDID.
   d. **IM-VITA-HDMIO** – connect FMC IMAGEON HDMI output to monitor capable of displaying Full HD resolution at 60 frames per second (1080p60). Connect Vita 2000 sensor with FMC IMAGEON board, use LCEDI connector.
2. Connect USB UART cable to J7 connector on TE0701-05 carrier board (JTAG/USB-to-Serial). Serial terminal settings:
   - Baud rate – 115200
   - Data bits – 8
   - Stop bits – 1
   - Parity – none
   - Flow control – none
3. Copy Zynq *BOOT.bin* file to SD card (directly to root). Chose the file according to used SoM (TE0720-02-1CF, TE0720-02-1QF or TE0720-02-2IF) and demo to be run, see Package Content Section 6.
4. Plug the SD card to TE0701-05 slot and power up the carrier board.
5. The serial terminal is used as the user interface. It prints the demo initialization sequence after start and user can execute control commands.

6 Package Content

```
.
|- doc/
|    `- appnote.pdf
|- firmware/
|    `- CC701_simple_CC701_10_mod.jed
|- pre-built/
     |- te0720-02-1cf-hdmio/
     |    `- BOOT.bin
     |- te0720-02-1cf-im-hdmii-hdmio/
     |    `- BOOT.bin
     |- te0720-02-1cf-im-hdmio/
     |    `- BOOT.bin
     |- te0720-02-1cf-im-vita-hdmio/
     |    `- BOOT.bin
     |- te0720-02-1qf-hdmio/
     |    `- BOOT.bin
```

```
|- te0720-02-1qf-im-hdmii-hdmio/
|    `- BOOT.bin
|- te0720-02-1qf-im-hdmio/
|    `- BOOT.bin
|- te0720-02-1qf-im-vita-hdmio/
|    `- BOOT.bin
|- te0720-02-2if-hdmio/
|    `- BOOT.bin
|- te0720-02-2if-im-hdmii-hdmio/
|    `- BOOT.bin
|- te0720-02-2if-im-hdmio/
|    `- BOOT.bin
`- te0720-02-2if-im-vita-hdmio/
     `- BOOT.bin
```

7 References

[1] Trenz, „TE0701 Carrier Board User Manual,“ 18 02 2014. [Online]. Available: https://wiki.trenz-electronic.de/display/4X5B/TE0701+Carrier+Board+User+Manual.

[2] Trenz, „TE0720 User Manual,“ 23 03 2015. [Online]. Available: http://www.trenz-electronic.de/fileadmin/docs/Trenz_Electronic/TE0720-GigaZee/documents/TE0720%20User%20Manual-v45-20150323_1407.pdf.

[3] AVNET, „HDMI Input/Output FMC Module,“ 26 08 2015. [Online]. Available: http://www.em.avnet.com/en-us/design/drc/Pages/HDMI-Input-Output-FMC-module.aspx.

[4] Sundance, „EMC2-DP – PC/104 ONEBANK CARRIER FOR SOC MODULES,“ 26 08 2015. [Online]. Available: http://www.sundance.technology/som-cariers/pc104-boards/emc2-dp/.

[5] AVNET, „ON Semiconductor Image Sensor with HDMI Input/Output FMC Bundle,“ 26 08 2015. [Online]. Available: http://www.em.avnet.com/en-us/design/drc/Pages/OnSemi-Image-Sensor-with-HDMI-Input-Output-FMC-bundle.aspx.

[6] Trenz, „Trenz WiKi - Lattice CPLD Programming,“ 25 08 2015. [Online]. Available: https://wiki.trenz-electronic.de/display/4X5B/TE0701+JTAG+Programming+Guide#TE0701JTAGProgrammingGuide-LatticeCPLDProgrammingLatticeCPLD.

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