

TE0720 User Manual

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Overview: TE0720 GigaZee Zynq SoM



Figure 1: TE0720 GigaZee Zynq SoM (REV 01).

Features

- 1. 1.5A, 4MHz PowerSoC DC-DC Step-Down Converter with Integrated Inductor (Enpirion EP53F8QI) for 1.8V Power Supply
- System Controller CPLD (Lattice LCMXO2-1200HC): 1,200 Macrocell CPLD with Block RAM, Flash and PLL
- 3. User LED 1 (Green)
- 4. User LED 2 (Red)
- 5. 32 Mbyte Quad SPI Flash memory (Winbond W25Q256FV)
- 6. MEMS sensor (ST Microelectronics LSM303DLMTR): 3-axis accelerometer and 3-axis magnetometer
- 7. Real Time Clock with Embedded Crystal (Intersil ISL12020M): ±5ppm Accuracy
- 8. 1Gbyte = 2x 256Mbitx16 (32-bit wide) DDR3 Memory (Memphis MEM4G16D3EABG-125I)
- 9. e-MMC NAND Flash (Micron MTFC4GMVEA-4M, may also be different manufacturer due to availability) usually 4 GByte, depends on assembly option
- Xilinx Zynq-7000 System-on-Module (Xilinx XC7Z020) Processing System: Dual ARM Cortex-A9, unified 512Kbyte L2 Cache, 256Kbyte on-chip Memory, 54 Multiplexed I/O Pins (MIOs); Programmable Logic: Artix-7 FPGA, 85K Logic Cells, 560 Kbyte extensible Block RAM (140x 36 Kbit BRAM Blocks), 220 programmable DSP Slices, Dual 12bit 1Msps Analog-to-Digital Converter, 200 I/O Pins (SelectIO Interfaces)
- 11. User LED 3 / FPGA Done (Green)



- 12. 4A High-Efficiency Power SoC DC-DC Step-Down Converter with Integrated Inductor (Enpirion EN6347) for 1.0V Power Supply
- 13. 1.5A, 4MHz PowerSoC DC-DC Step-Down Converter with Integrated Inductor (Enpirion EP53F8QI) for 1.5V Power Supply
- 14. Trenz 4x5 Module Socket Connector (3x Samtec LSHM Series Connectors)
- 15. Gigabit Ethernet Transceiver PHY (Marvell 88E1512)
- 16. Highly Integrated Full Featured Hi-Speed USB 2.0 ULPI Transceiver (Microchip USB3320C-EZK)

Document Change History

date	revision	authors	description
2014-02-10	0.2	Sven-Ole Voigt	Work in progress
2013-04-17	0.1	Antti Lukats, Thorsten Trenz	Initial release
	All	Antti Lukats, Thorsten Trenz, Sven-Ole Voigt	



Overview

Trenz Electronic GigaZee XC7Z series are industrial-grade SoMs (system on modules) integrating a leading-edge Xilinx Zynq-7000 SoC, gigabit Ethernet transceiver, 32-bit-wide 1 gigabyte DDR3 SDRAM, 32 megabyte SPI Flash memory for configuration and operation, eMMC, and powerful switch-mode power supplies for all on-board voltages. A large number of configurable I/Os is provided via robust board-to-board (B2B) connectors. All this on a tiny footprint smaller than half a credit card, at the most competitive price. Development boards are available in our online shop; reference designs are available in our open design repositories.

Sample Applications

- Cryptographic hardware module
- Digital signal processing
- Embedded industrial OEM platform
- Embedded system design
- Emulation platforms
- FPGA graphics
- FPGA video processing
- Image processing
- IP (intellectual property) cores
- Parallel processing
- Rapid prototyping
- Reconfigurable computing
- System-on-Chip (SoC) development





Key Features

- Industrial-grade Xilinx Zynq-7000 SoM (system on module)
- Rugged for shock and high vibration



- ARM dual-core Cortex-A9 MPCore @ up to 800 MHz
- 10/100/1000 tri-speed gigabit Ethernet transceiver (PHY), SGMII accessible on a board-to-board connector
- USB 2.0 high-speed ULPI transceiver
- 32-bit-wide 1 Gbyte DDR3 SDRAM
- 32 Mbyte SPI Flash memory supporting XiP
- 4 Gbyte e-MMC (up to 64 Gbyte)
- Plug-on module with 2 × 100-pin and 1 × 60-pin high-speed hermaphroditic strips
- 152 FPGA I/Os (75 LVDS pairs possible) and 14 MIOs available on board-to-board connectors
- 4.0 A x 1.0 V power rail
- 1.5 A x 1.5 V power rail
- 1.5 A x 1.8 V power rail
- System management and power sequencing
- eFUSE bit-stream encryption
- AES bit-stream encryption
- Valid MAC Address and 2 kilobit serial EEPROM
- SHA-256 authentication chip with unique serial number
- temperature compensated RTC (real-time clock)
- MEMS sensor (3-axis accelerometer and 3-axis magnetometer)
- 3 user LEDs
- Evenly-spread supply pins for good signal integrity
- Other assembly options for cost or performance optimization available upon request



Getting Started

Preloaded (Factory default) SPI Flash Image

The TE0720 module comes with the SPI Flash preloaded with a default bootloader, U-Boot and Linux are setup to run automatically if SPI flash boot mode is selected (Red LED fast blinking after power up). U-Boot is configured with a standard 3 second delay to allow the U-Boot interactive console to be used. The console is connected to PS UART0, mapped to MIO14 (UART0_RX) and MIO15 (UART0_TX), and has a baud rate of 115200. The MIO14 and MIO15 signals are routed to the CPLD on the TE0701 Carrier Board which, in turn, connects these PS UART0 RX and TX signals to the onboard FTDI USB to Multipurpose UART/FIFO IC (FTDI FT2232H). Hence, the console output view can be easily accomplished (e.g., in SDK "Terminal" window or in HTerm) by attaching it to the corresponding virtual COM port (the COM port number may differ):

Please consult TE0701 Carrier Board User Manual | Connecting FTDI USB-to-UART/FIFO Interface for more details on the required VCOM configuration!



Figure 1: Booting Linux Kernel (by default from SPI Flash) - SDK "Terminal" window



HTerm 0.8.1beta		X
Eile Options View Help		
Disconnect Port COM3 R Baud 115200 Data 8 Stop 1 Parity None CTS Flow control 1.		
Rx 4265 Reset Tx 0 Reset Count 0 - 2 Reset Newline at CR+LF Characters		
Clear received 🗸 Ascii Hex Dec Bin Save output 💌 Clear at 0 🔿 Newline every 0 🐳 🗸 Autoscröll Show errors Newline after ms 0 🔿 🖓	rs dsr i	RI DCD
Received Data		
1 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105 110 U-Boot 2013.01-00003-g8e60280-dirty (Jun 13 2013 - 01:51:50)) 115	^
I2C: ready DRAM: 1 G1B WARNING: Caches not enabled MMC: zynq_sdhci: 0 SF: Detected W25Q256 with page size 4 K1B, total 32 M1B *** Warning - bad CRC, using default environment		=
In: serial Out: serial Err: serial Nat: Gem.e000b000		
Hit any key to stop autoboot: 3 www 2 www 1 www 0		
Copying Linux from QSP1 flash to RAM SF: Detected W25Q256 with page size 4 KiB, total 32 MiB ## Booting kernel from Legacy Image at 03000000 Image Name: Linux-3.6.0-g8f74534-dirty Image Type: ARM Linux Kernel Image (uncompressed) Data Size: 2906848 Bytes = 2.8 MiB Load Address: 0008000 Verifying Checksum OK ## Loading init Ramdisk from Legacy Image at 02000000 Image Name: Image Name: Image Type: ARM Linux RAMDisk Image (gzip compressed) Data Size: 5309995 Bytes = 5.1 MiB Load Address: 0000000 Verifying Checksum OK ## Flattened Device Tree blob at 02a00000 Loading Kernel Image OK ## Flattened Device Tree blob at 02a00000 Loading Ramdisk to 1faef000, end 1ffff62b OK Loading Device Tree to 1faea000, end 1faeebb0 OK Starting kernel		
Selection (~)		*
Input options		
Clear transmitted Ascii Hex Dec Bin Send on enter None V Send file DTR RTS		
Type ASC V	A	Send
Transmitted data		×
1 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105 110) 115	
History -/0/10 Connect to COM3 (b:115200 d:8 s:1 p:No	one)	ai

Figure 2: Booting Linux Kernel (by default from SPI Flash) - Another (optional) console output, e.g., in HTerm

After sucessfully starting the kernel on Xilinx Zynq, the following Linux prompt appears:



C/C++ - Xilinx SDK		x
File Edit Source Refactor Navigate Search Run Project Xilinx Tools Window Help		
□ ●		<u>C/</u> »
🕼 Problems 🖗 Tasks 🕞 Console 🗔 Properties 🖉 Terminal 1 🔅 📓 XMD Console 🏶 Debug		
Serial: (COM3.115200. 8. 1. None. None - CONNECTED) - Encoding: (ISO-8859-1))		8
ALSA device list:		
No soundcards found.		
RAMDISK: gzip image found at block 0		8
VFS: Mounted root (ext2 filesystem) on device 1:0.		in the second s
devtmpfs: mounted		۲
Freeing init memory: 156K		\sim
Starting rcS		
++ Mounting filesystem		
mount: mounting /dev/mmcblk0p1 on /mnt failed: No such file or directory		
mount: mounting /dev/mmcblk0 on /mnt failed: Invalid argument		
++ Setting up mdev		
++ Starting telnet daemon		
++ Starting http daemon		
++ Starting tip daemon		
++ Starting SSN daemon	Ξ	
2yndx 🗖	Ψ.	
	8	ß

Congratulations! You have been successfully booting up the preloaded SPI Flash image on the TE07020 GigaZee Zynq SoM.

A The preloaded images provided are to demonstrate the board's capability. It is expected that the customer will replace them with their own images.

Boot Procedure

FSBL (First Stage Bootloader)

The primary boot source for the TE0720 is the on-board SPI Flash. After power on the Zynq PS boot ROM fetches the FSBL from the SPI Flash and executes it. Then the FSBL code takes over and initializes the Zynq PS peripherals as well as the DDR3 memory controller. Finally the FSBL proceeds to load the PS object code or FPGA configuration data. Primary factory FSBL for the TE0720 only loads SSBL (Second Stage Bootloader) from SPI Flash and executes it. This way it is possible to boot the O/S (Linux) with or without configuring the FPGA Fabric. Boot configuration can select the order of the images to be loaded. It is possible that the SSBL loads the FPGA only, loads the FPGA and then loads and executes application (O/S) code, or loads the user application without configuring the FPGA fabric.

FPGA images and application code can reside in on-board SPI Flash, in on-board eMMC or on an external SD card.

Note: an FSBL image can not be loaded from eMMC. FSBL is fetched from SPI Flash or from an external SD card.



Note: Xilinx wizard generated FSBL does not properly initialize the SD card detect multiplexer values. By default MIO0 remains selected. If writing your own FSBL it is necessary to initialize it properly. TE0720 standard FSBL selects the EMIO63 pin for SD card detect and WP inputs (this forces the card detect to succeed).

SD0_WP_CD_SEL = 0x003F003F;

SD1_WP_CD_SEL = 0x003F003F;

Pseudo code to initialize the CD and WP selection bit to point to EMIO63 (tied low if not connected in user logic).

SSBL (Second Stage Bootloader)

Second stage bootloader is usually fetched from SPI flash. By default a customized U-Boot is used which is responsible for loading the O/S. If U-Boot functionality is not needed then the user application could be implemented as SSBL image.

Boot Modes

The Zynq-7000 generally supports several boot modes that can be selected by five boot mode pins BOOT_MODE[4:0], where BOOT_MODE[4] / MIO[6] enables the PLLs. The other boot mode pins select the boot source in the following way (see Xilinx Zynq-7000 AP SoC Technical Reference Manual, UG585 v1.6.1, Table 6-2 on page 147):

	BOOT_MODE[0] MIO[5]	BOOT_MODE[2] MIO[4]	BOOT_MODE[1] MIO[3]	BOOT_MODE[3] MIO[2]
Cascaded JTAG				0
Independent JTAG				1
JTAG	0	0	0	0
Quad-SPI	1	0	0	
SD Card	1	1	0	

Table 1: Zynq-7000 AP SoC Boot_Mode MIO Pins (Extract)

As it can be seen in Table 1 the only difference between *Quad-SPI* and *SD Card* boot mode is BOOT_MODE[2] / MIO[4]. This is exactly the only signal which is controlled by the MODE output of the TE0701 on-board CPLD. The BOOT_MODE[0] / MIO[5] and BOOT_MODE[1] / MIO[3] input pins are tightend correspondingly, e.g., on the TE0720 Zynq SoC Module to pull-up (i.e., SPI-DQ3/M3 = PS_MIO5 = 1) and pull-down (i.e., SPI_DQ1/M1 = PS_MIO3 = 0) resistors.



A The TE0720 Zynq SoC Module on the TE0701 Carrier Boards supports two different boot modes: QSPI and SD Card booting. For more information on configuring the boot mode please refer to " TE0701 Carrier Board User Manual | Configuring Boot Mode".

QSPI Boot Mode

Xilinx Answer record AR47023

Currently writing to the SPI Flash is only possible from Vivado SDK starting from 2013.4 version. Writing from Impact (any version) is not supported.

U-Boot functions can be used to update SPI Flash.

Xilinx Answer record AR57744 need to be followed, currently the system controller firmware does not provide this safety function.

Update the SPI Flash from an SD Card

To update SPI Flash contents from files stored on an SD card use the U-Boot commands "fatload" and "sf".

Example:

Read boot.bin from SD Card to memory address 0x1000000

fatload mmc 0 0x1000000 boot.bin

Initialize SPI Interface

sf probe 0 0 0

Write 0x450000 bytes from address 0x1000000 to offset 0 in SPI Flash

sf update 0x1000000 0 0x450000

The default U-Boot environment has predefined command sequences to update SD Flash from an SD card. This update contain files used for Linux boot (boot.bin, ulmage, uramdisk.image.gz and tevicetree.dtb).

run sdfetch

run reflash_all

Update the SPI Flash from a network

To update SPI Flash via Ethernet the U-Boot commands "tftp" and "sf" can be used.

Host PC network interface should have IP address 192.168.42.2. Direct connection from a host PC to the board is recommended. It is possible to change the IP address of the board from U-Boot, but there could be other issues when the connection goes via a corporate network.

TFTP server software should be installed on the host PC to provide file access via the TFTP protocol. A TFTP server is no longer provided by Microsoft as part of the Windows O/S, so third-party software must be used.

Example of TFTP server configuration

- Download OpenTFTPServer from http://sourceforge.net/projects/tftp-server/
- Install OpenTFTPServer
- Run Open TFTP Server -> Configure from Start menu
- Edit configuration file.

[LISTEN-ON] 192.168.42.2 [HOME] c:\firmware\ [LOGGING] All [ALLOWED-CLIENTS] [TFTP-OPTIONS]

• Run Open TFTP Server -> Run Stand Alone

After configuration files in C:\firmware can be downloded via TFTP.

Example:

Download boot.bin from host PC to memory address 0x1000000

tftp 0x1000000 boot.bin

Initialize SPI Interface

sf probe 000

Write 0x450000 bytes from address 0x1000000 to offset 0 in SPI Flash

sf update 0x1000000 0 0x450000



SD Card Boot Mode

TE0720 can also boot directly from an SD card. In this mode SPI Flash is not used (all code starting from the FSBL is loaded from the SD card).

SDIO0 Bootable slot MIO pins have a 1.8V fixed I/O voltage so the SD card must be connected via a level shifter on the carrier board.

Programming the FPGA with new Configurations

Configuring the FPGA via JTAG

Either Xilinx Impact or ChipScope can be used to load bitstreams over JTAG.

Configuring the FPGA by the Processing System (PS)

Files that can be used for FPGA configuration using the PS DEVCFG interface have to be binary bitstreams with the preamble stripped and the bytes swapped within 32-bit words. The Xilinx bitgen tool can produce files with a BIN extension and a stripped header, but the generated files do not have the correct byte swap.

Example for "promgen" parameters to convert bitstream "top.bit" to byte-swapped binary file "top.bin":

promgen.exe -w -b -p bin -o top.bin -u 0 top.bit -data_width 32

Bitstreams that do include PS instantiation have to be generated with CCLK as the startup clock.

Configuring the FPGA with U-Boot

The FPGA can be configured or reconfigured from the U-Boot prompt:

zynq-uboot> nm 0xf8007080
f8007080: 00000010 ? 0
f8007080: 00000000 ? x
zynq-uboot> nm 0xf8007080
f8007080: 00000000 ? x
zynq-uboot> fatload mmc 0 0x100000 top.bin
reading top.bin
4045564 bytes read in 628 ms (6.1 MiB/s)
zynq-uboot> fpga load 0 0x100000 0x3dbafc



Writing 0 to address 0xF8007080 is a temporary fix for the first revision of the FSBL shipped. It is required to make the FPGA configuration correctly both in U-Boot and in Linux. An explanation has been given by a Xilinx employee on the Xilinx User Community Forums.

Configuring the FPGA in Linux

The FPGA can also be configured within Linux:

zynq> mkdir /tmp/sd zynq> mount /dev/mmcblklp1 /tmp/sd zynq> cd /tmp/sd zynq> cat top.bin > /dev/xdevcfg

You must apply the write to address 0xF8008070 in U-Boot before booting Linux, otherwise the FPGA load will fail.



Detailed Description

Overview



Figure 2: TE0720 GigaZee Zynq SoM Block Diagram



System Management, Power Supply & Resets



Figure 3: Overview: TE0720 System Management, Power Supply & Resets

¹ Note: The DDR3 SDRAM size depends on assembly option.

² 1.0V and 1.8V TE0720 power supply circuits are not shown to create a better overview (see TE0720 User Manual | Power Supply for more details).

³ Four independent VCCIO voltages (VCCIO13, VCCIO33, VCCIO34, VCCIO35) are fully customizable (1.5V, 1.8V, 2.5V, 3.3V) and can be chosen application-specifically (on a user defined "Carrier Board"). For example, on our "TE0701-03 Carrier Board" the VCCIO voltages have been chosen on the one hand for VCCIO33 and VCCIO34 to be 2.5V by default (or alternatively 3.3V) and on the other hand for VCCIO13 and VCCIO35 to be the user-programmable FMC_VADJ voltage via I2C (see TE0720 User Manual | Carrier Boards for TE0720 - Configuring FMC Power Supply Voltage) by default (or alternatively 2.5V and 3.3V, respectively).

System Management Controller (SC)

Overview: System Management Controller (SC)

A Lattice XO2-1200 CPLD is used as a System Management Controller (referred to as SC in the manual). The SC is responsible for power sequencing, reset generation and Zynq initial configuration (mode pin strapping). Moreover, some on-board ICs are connected to the SC that provides level shifting.

It is possible for the default SC functions and pin functions to be changed. This can be done as a request to Trenz Electronic or it is possible for the user to generate their own designs. Please contact us for details.

The SC wakes up when the 3.3V input power rises above 2.1V (VIN voltage is not needed). The SC can turn on or off all of the other supplies on the module (except in no power sequencing mode when the 1.0V and 1.8 V supplies are forced to start immediately when power is applied to the module).

Custom SC Programming

SC customization is available either by requesting new features or with special agreement by using the users own code. SC code can be updated in the system using the I2C interface. Please contact us for details.

SC B2B Pins

SC is connected directly to the following B2B Pins.

Name	Mode	Default function	Alternative	Description
EN1	input, weak pull-up	Power Enable	Ю	Enables the DC-DC converters and on-board supplies. Not used if NOSEQ=1
PGOOD	output, open drain	Power good	SCL or IO	Forced low until all on-board power supplies are working properly.
MODE	input, weak pull-up	Boot mode	SDA or IO	Force low for boot from the SD Card. BOOTMODE is latched at power on only.
RESIN	input, weak pull-up	Reset input	Ю	
NOSEQ	input, weak pull-down	Power sequencing Control	Output	Forces the 1.0V and 1.8V DC-DC converters ON when high. Can be used as an I/O after boot.

NOSEQ Pin

This is a dedicated input that forces the module's 1.0V and 1.8V supplies to be enabled if high. This pin has a weak pull-down on the module. If left open the module will power up in normal power sequencing enabled mode. This pin is 3.3V tolerant. This pin is also connected to the System Management Controller. The SC can read the status of this pin (that is it can detect if the module is in power sequencing enabled mode). The SC can also use this pin as output after normal power on sequence. Please check the SC description for the function. SC rev 0.02 maps Ethernet PHY LED0 to NOSEQ by default (the mapping can be changed by software after boot).



No Sequencing mode

If the module is powered from a single 3.3V supply and power sequencing is disabled, then NOSEQ pin should be powered from the main 3.3V input. That is VIN, 3.3Vin and NOSEQ should all be tied together to the input 3.3V power rail. Sequencing mode should not be used if VIN is not 3.3V.

Normal mode

For normal operation leave NOSEQ open or pull down with a resistor.

Normal mode with user function on NOSEQ

NOSEQ can be used as an output after boot. NOSEQ must be low when 3.3V power is applied to the module. Common usage is an LED connected between NOSEQ and GND.

SC pins to the FPGA

	Default function	Direction	Description
XCLK	Clock to FPGA	to FPGA	
XIO1	Clock from FPGA	from FPGA	SCL from EMIO I2C1
XIO2	Data from FPGA	from FPGA	SDA from EMIO I2C1
XIO3	Data to FPGA	to FPGA	SDA to EMIO I2C1
XIO4	ETH PHY LED1	to FPGA	
XIO5	ETH PHY LED2	to FPGA	
XIO6	Interrupt	to FPGA	RTC, MEMS

Default Mode

At power up the System Management Controller starts with default settings.

Pin/Function	Used as/Mapped to	Notes
ETH PHY LED0	XIO to FPGA	
ETH PHY LED1	XIO to FPGA	
ETH PHY LED2	Not used	
ETH PHY CONFIG	Tied logic low	PHY Address set to 0
ETH CLK125MHz	Pass through FPGA B34 SRCC pin	
ETH Clock Enable	Tied logic high	
ETH PHY Reset	Internal RESET	
MIO7	LED1	
MEMS/RTC I2C	XIO to FPGA	
RTC Interrupt	-	
MEMS Interrupt 1	-	
MEMS Interrupt 2	-	



Pin/Function	Used as/Mapped to	Notes
eMMC Reset	Internal RESET	
USB PHY Reset	Internal RESET	
FPGA PUDC	Tied logic low	
FPGA PROG_B	Tied logic high	
Zynq Cascaded JTAG	Enabled (pulled low)	
Zynq boot mode	SPI or SD, depending on bootmode pin	
Zynq SRST	Tied logic high	
Zynq POR	Internal POR/Reset	
PLL	Not used	
LED2	System Status LED	
LED1	MIO7	
NOSEQ Input	NOSEQ at power, LED out after boot	
Power Good 1.5V		
Power Good VTT		
MODE Input		

I2C Address	Function
0x20	Status reg 1
0x21	Status reg 2

LED Control Status

The TE0720 on-board LED devices can be remapped to different functions.

Input port bit	Mapped to
0	Ethernet PHY LED0 output
1	Ethernet PHY LED1 output
2	Ethernet PHY LED2 output
3	PS MIO7
4	Returns RESIN pin level
5	Returns EN1 pin level
6	Returns NOSEQ pin level
7	Returns MODE pin level

LED1 and LED2 function can be changed from the default behaviour using output port bits (3..0)



D3	D2	D1	D0	LED1 function as
0	0	0	0	Default (MIO7)
0	0	0	1	ETH PHY LED0
0	0	1	0	ETH PHY LED1
0	0	1	1	ETH PHY LED2
0	1	0	0	MIO7
0	1	0	1	Undefined
0	1	1	0	OFF
0	1	1	1	ON
1	x	x	x	Undefined

SC Demystified

System Controller (SC for short) was designed to allow ZYNQ PS system to access module special functions as early as possible without reducing the number of MIO pins that are fully user configurable.

This early communication channel is done using MIO52 and MIO53 pins that are used also as Ethernet PHY management interface for the on-board Gigabit PHY.

In order to simplify the boot process and reduce the number of time the PS peripherals need to be configured or re-initialized SC uses the same protocol on MIO52/MIO53 as the Gigabit PHY itself. This means that FSBL Configures all peripherals to their final function, allocating MIO52 as MIO52 as Ethernet MDIO Interface.

SC Controller appears as "Virtual Ethernet PHY" on the MDIO bus of PS Ethernet 0 Interface. This interface is already available when Zynq PL Fabric is not configured.

It would have been possible to use I2C Protocol on MIO52/MIO53 but in such case some multiplexing would be be needed to choose between two protocols, also it would be needed to change the Peripheral mapping after first init by the FSBL.

For use cases where Ethernet PHY on TE0720 is not used at all, it is still possible to configure SC with design that implements I2C Protocol on MIO52/MIO53 pins.

For most use cases the only need to use this interface is access to MAC Address info, this is normally done by u-boot loader that fetches the MAC Address bytes and sets its environment variables accordingly. Linux image will then also be started so that the MAC Address from EEPROM is used for Ethernet 0 Physical interface.

Important: u-boot still has trouble properly initializing Ethernet PHY registers. So that with standard u-boot distribution MII Commands are not available from withing u-boot, those commands will just fail, and all 0's will be read from all PHY addresses. This is not a design issue with SC, it is u-boot problem that is not fixed in mainstream u-boot repositories. PHY Init has changed with u-boot versions but the problem is still there, and more severe in the latest revisions of u-boot. PHY initialization fix in u-boot board support file that worked in 2013.1 uboot is no longer working in 2014.1 uboot version.



- • ×

Putty

```
U-Boot 2014.01-dirty (Jun 13 2014 - 07:08:53)
I2C:
      ready
Memory: ECC disabled
DRAM: 128 MiB
MMC: zynq_sdhci: 0
SF: Detected S25FL256S_64K with page size 256 Bytes, erase size 64 KiB, total 32 MiB
*** Warning - bad CRC, using default environment
In:
       serial
Out:
       serial
Err:
     serial
Net: Gem.e000b000
Hit any key to stop autoboot: 0
zynq-uboot> mii info
PHY 0x00: OUI = 0x0000, Model = 0x00, Rev = 0x00, 10baseT, HDX
PHY 0x01: OUI = 0x0000, Model = 0x00, Rev = 0x00, 10baseT, HDX
PHY 0x02: OUI = 0x0000, Model = 0x00, Rev = 0x00, 10baseT, HDX
PHY 0x03: OUI = 0x0000, Model = 0x00, Rev = 0x00, 10baseT, HDX
PHY 0x04: OUI = 0x0000, Model = 0x00, Rev = 0x00, 10baseT, HDX
PHY 0x05: OUI = 0x0000, Model = 0x00, Rev = 0x00, 10baseT, HDX
PHY 0x06: OUI = 0x0000, Model = 0x00, Rev = 0x00, 10baseT, HDX
PHY 0x07: OUI = 0x0000, Model = 0x00, Rev = 0x00, 10baseT, HDX
PHY 0x08: OUI = 0x0000, Model = 0x00, Rev = 0x00,
                                                       10baseT, HDX
PHY 0x09: OUI = 0x0000, Model = 0x00, Rev = 0x00, 10baseT, HDX
PHY 0x0A: OUI = 0x0000, Model = 0x00, Rev = 0x00, 10baseT, HDX
PHY 0x0B: OUI = 0x0000, Model = 0x00, Rev = 0x00, 10baseT, HDX
PHY 0x0C: OUI = 0x0000, Model = 0x00, Rev = 0x00, 10baseT, HDX
PHY 0x0D: OUI = 0x0000, Model = 0x00, Rev = 0x00, 10baseT, HDX
PHY 0x0E: OUI = 0x0000, Model = 0x00, Rev = 0x00,
                                                       10baseT, HDX
PHY 0x0F: OUI = 0x0000, Model = 0x00, Rev = 0x00,
                                                       10baseT, HDX
PHY 0x10: OUI = 0x0000, Model = 0x00, Rev = 0x00, 10baseT, HDX
PHY 0x11: OUI = 0x0000, Model = 0x00, Rev = 0x00, 10baseT, HDX
PHY 0x12: OUI = 0x0000, Model = 0x00, Rev = 0x00, 10baseT, HDX
PHY 0x13: OUI = 0x0000, Model = 0x00, Rev = 0x00, 10baseT, HDX
PHY 0x14: OUI = 0x0000, Model = 0x00, Rev = 0x00, 10baseT, HDX
PHY 0x15: OUI = 0x0000, Model = 0x00, Rev = 0x00, 10baseT, HDX
PHY 0x16: OUI = 0x0000, Model = 0x00, Rev = 0x00, 10baseT, HDX
PHY 0x17: OUI = 0x0000, Model = 0x00, Rev = 0x00, 10baseT, HDX
PHY 0x18: OUI = 0x0000, Model = 0x00, Rev = 0x00, 10baseT, HDX
PHY 0x19: OUI = 0x0000, Model = 0x00, Rev = 0x00, 10baseT, HDX
PHY 0x1A: OUI = 0x0000, Model = 0x00, Rev = 0x00, 10baseT, HDX
PHY 0x1B: OUI = 0x0000, Model = 0x00, Rev = 0x00, 10baseT, HDX
PHY 0x1C: OUI = 0x0000, Model = 0x00, Rev = 0x00,
                                                       10baseT, HDX
PHY 0x1D: OUI = 0x000, Model = 0x00, Rev = 0x00,
PHY 0x1E: OUI = 0x0000, Model = 0x00, Rev = 0x00,
                                                       10baseT,
                                                                HDX
PHY 0x1E: OUI = 0x0000, Model = 0x00, Rev = 0x00, 10baseT, HDX
PHY 0x1F: OUI = 0x0000, Model = 0x00, Rev = 0x00, 10baseT, HDX
                                                                                                Ξ
zynq-uboot> mm e000b000
e000b000: 00000000 ? 10
e000b004: 00080000 ? x
zynq-uboot> mii info
PHY 0x00: OUI = 0x5043, Model = 0x1D, Rev = 0x01,
                                                       10baseT, HDX
PHY 0x1A: OUI = 0x7202, Model = 0x01, Rev = 0x00,
                                                       10baseT, HDX
zynq-uboot>
```

Initial MII info in uboot 2014.1 finds "fantom" PHYs that all read 0's from all registers. After enabling MII Interface (that u-boot itself should do during init) MII Info command shows correctly PHY at address 0 what is the Marvell Gigabit PHY and virtual PHY at address 0x1A what is the SC. The above is what uboot will show if the MDIO enable bit was not set in the FSBL.



SC Firmware ver 0.02

This is the initial version of the System Controller with only a very limited function set implemented.

System Controller can be accessed as PHY with address 0x1A on the ETH0 Management bus (MIO pins 52, 53). Communication can be established anytime when ETH0 and management interface are enabled also before FPGA PL Fabric is configured. Xilinx default FSBL and standard u-boot do not enable the management interface. It can be done manually in u-boot

```
zynq-uboot> mm e000b000
e000b000: 00000010 ? 10
e000b004: 00080000 ? x
zynq-uboot>
```

The above command enables the management interface on ETH0. TE0720 FSBL does this already so there is no need to do it manually. This command is needed when standard Xilinx wizard generated FSBL is used with plain standard u-boot, TE0720 u-boot does this initialization also. Note: It seems the problem is in the current u-boot for Zynq, where mii_init function is not defined and not invoked.

Version check

System Controller Firmware version and some other version info can be read with u-boot command mii info:

```
zynq-uboot> mii info
PHY 0x00: OUI = 0x5043, Model = 0x1D, Rev = 0x01, 100baseT, FDX
PHY 0x1A: OUI = 0x7201, Model = 0x01, Rev = 0x00, 10baseT, HDX
zynq-uboot>
```

PHY at address 0x00 is the ETH0 onboard ethernet PHY Marvell 88E1512.

PHY at address 0x1A is the System Controller. OUI 0x7201 should be decoded as Model TE0720-01. Model 0x01 is Assembly option. Rev 0x00 is the firmware major revision for the System Controller (Rev 0 is the initial version).

Reg Addr	Bits	u-boot ENV Variable	Description
2	15:0	board	upper bits of SoM Model
3	15:10	board	lower bits of SoM Model
3	9:4	-	Assembly Variant
3	3:0	scver	SC Firmware Revision Major number
4	15:14	board	FPGA Speed Grade
4	13:12	board	FPGA Temperature Range (0=Commercial, 1=Extended, 2=Industrial)
4	7:0	scver	SC Firmware Revision Minor number

Bit Decoding

Customized u-boot reads and decodes the model and assembly variant information and stores in readable format in environment variables.



zynq-uboot> printenv board board=TE0720-01-2IF zynq-uboot>

Reading MAC Address

With u-boot command mii read:

zynq-uboot> mii read la 9-b addr=la reg=09 data=0004 addr=la reg=0a data=A3AC addr=la reg=0b data=3911 zynq-uboot>

This command will read MAC Address from the System Controller. Note: This only works if the ETH0 interface is enabled and if FSBL has enabled MII Management console on ETH0 Interface. 0004A3 is OUI part, AC3911 is the serialized part (lower bits of MAC address).

Customized u-boot does read MAC Address and stores it in environment variables as required, as a result, proper MAC address is used both in u-boot as also in Linux. Setting up MAC Address for Linux involves dynamic rewrite of FDT, this is done with u-boot script that starts Linux.

SC Registers

Most registers and functions are available via ETH PHY Management interface (MIO pins 52 and 53).

Addr	R/W		Descripion
0	RO		
1	RO		
2	RO	ID1	Identifier Register 1
3	RO	ID2	Identifier Register 2
4	RO	ID3	Identifier Register 3
5	RW	CR1	Control Register 1: LED's
6	RW	CR2	Control Register 2; XIO Control
7	RW	CR3	Control Register 3; Reset, Interrupt
8	RO	SR1	Status Register
9	RO	MAChi	Highest bytes of primary MAC Address
0xA	RO	MACmi	Middle bytes of primary MAC Address
0xB	RO	MACIo	Lowest bytes of primary MAC Address
0xC	-		reserved do not use
0xD	RW	MMD_CR	MMD Control Register
0xE	RW	MMD_AD	MMD Address/Data
0xF	-		reserved do no use



Addr	R/W	Descripion
other	-	reserved do not use

System Controller version 0.02 does not support extended address space - registers 0xD and 0xE are read-write accessible but do not have any function. In feature revision extended address will be used to control SC PLL and other features.



Power Supply

Power Supply Specifications

High-performance DC-DC converters from Enpirion are used for most of the power rails.

Power Sequencer and System Management

Xilinx ZYNQ devices require special power sequencing. The voltage difference between 1.8V VCCAUX and any I/O Voltage must not be higher than 2.65V for a combined duration of 800 ms for each power on-off cycle (or 500 ms at higher temperatures). If TE0720 is operating in "no power sequencing" mode this period time of 800 ms (and 500 ms, respectively) will never be violated in normal use. TE0720 can also be used in power sequencing mode where the 3.3V voltage plane is supplied from 3.3Vin (CPLD power supply) by a dedicated power FET switch (that is, in turn, controlled via an enable signal by the CPLD SC) after the 1.0V and 1.8V supplies have stabilized. However, in power sequencing mode user circuitry must also comply to power-up sequencing rules; VCCIO voltages that are over 2.5V must be turned off when TE0720 has not turned on the core supplies.



Simplified Power Good signal generation.

Rail	Input/Output	Powered from	v	I Rating	Monitored	UVLO	XADC
Vin	Input	External	3.3 - 5.5	8A Connector	>2.2V (indirect by DCDC)	2.2V	
Vin 3.3V	Input	External	3.3	2A Connector	>2.5V (indirect by SC)		
3.3V	Output *1	Vin 3.3V	3.3	2A Connector	>= 3.05V		
1.0V	Internal	Vin	1.0	4A DCDC	+-10%	2.3V	Yes (internal)
1.8V	Internal / Output	Vin	1.8	1.5A DCDC	+-10%	2.2V	Yes (internal)
1.5V	Internal / Output	Vin	1.5	1.5A DCDC	+-10%	2.2V	Yes (internal)
VTT	Internal	1.5V	0.75	+-2A LDO	+-20%	2.3V	indirect via VTTREF
VTTREF	Internal	1.5V	0.75	+-10mA LDO	+-20 (indirect tracks VTT)	2.3V	Yes (Channel 0)
VCCIO_34	Input	External *2	1.5 - 3.3	2A Connector	>= 1.25V		
VCCIO_13	Input	External *2	1.2 - 3.3	2A Connector	not monitored		
VCCIO_33	Input	External *2	1.2 - 3.3	1A Connector	not monitored		

Power Rails



Rail	Input/Output	Powered from	v	I Rating	Monitored	UVLO	XADC
VCCIO_35	Input	External *2	1.2 - 3.3	2A Connector	not monitored		

*1 When used in 3.3V single power supply mode with no sequencing this pin can be connected to Vin 3.3V

*2 PL I/O Bank VCCIO Inputs can be connected to the module's 3.3V output (for 3.3V I/O Voltage Banks).

I/O Voltages

I/O Bank	Voltage	Notes
PS MIO Bank 0	3.3	SPI Flash, 8 MIO pins on B2B connector
PS MIO Bank 1	1.8	USB PHY, Ethernet PHY, eMMC, 6 MIO pins on B2B connector
PL Bank 0	3.3	
PL Bank 34	1.5 - 3.3	When Bank 34 VCCIO is below 1.25, ZYNQ is held in POR reset state
PL Bank 13	1.2 - 3.3	
PL Bank 33	1.2 - 3.3	
PL Bank 35	1.2 - 3.3	
Ethernet PHY	1.8	
USB PHY	1.8	
eMMC	1.8	

Example Application Diagrams

Dual Supply Application



Example power connections. On-board DC-DC converters are supplied separately from 3.3V circuits. All VCCIO Bank Voltages should be derived either from the 3.3V output or controlled by the Power Good signal.



For single supply mode with power sequencing enabled, use the same configuration with Vin powered from 3.3V.

3.3V Single Supply with no Power Sequencing



This is simplest application where all power is derived from single a single 3.3V supply with no power sequencing. All FPGA I/O Banks should be powered from the same 3.3V supply either directly or using a LDO/DC-DC supply. This configuration is used for backwards compatibly with motherboards designed for the TE0600 module. EN1 pin in this configuration does not turn off any of the on-board power supplies. Holding EN1 pin low will assert the POR (power on reset) to the ZYNQ. EN1 can be left floating, pulled up or connected to 3.3V.

XADC Power

For best noise performance XADC is powered from a separate on-board, low power, 1.8V LDO. The LDO provides an Analog power supply for the ZYNQ XADC circuits and also for an on-board 1.25V reference IC. Those components are placed within 3 mm of the BGA package balls on the PCB bottom side.

Backup Battery

The RTC IC is powered from a backup battery which should have a nominal voltage of 3.2V to 3.3V. The ZYNQ internal AES security RAM is also powered from the same VBATT pin as the RTC chip. The backup supply pin on the ZYNQ is connected to VBATT via an ultra-low power LDO.

Operating with a power supply of less than 3.1V

The TE0720 System Managment Controller normally prevents the ZYNQ device from booting if the power is less than 3.05V. In certain cases it is possible to allow the TE0720 module to be operated from a single 2.5V to 2.7V supply. At these voltages the SPI flash boot option is not available and the on-board eMMC is not usable. Boot is only possible via JTAG, or optionally from external SD Card supporting low-voltage operating modes. This option is only considered on special request.

AC & DC Characteristics

AC Characteristic

	-3	-2	-1
ARM CPU Max	800	733	667
PS DDR3	1066	1066	1066
Logic F/F Toggle	1412	1286	1098
Block RAM	509.68	460.83	388.20
DSP48E1	628.93	550.66	464.25
Global Clock Tree and BUFH	628.0	628.0	464.4
I/O Clock Tree	680	680	600
Regional Clock	420	375	315
MMCM/PLL input or output	800	800	800

Max AC performance in MHz per ZYNQ speed grade. The above table shows some maximum clock frequencies for the PS and PL subsystems of the ZYNQ SoC. Please consult Xilinx datasheets for detailed performance information.

DC Characteristic

Power input pin	Max current
VIN	
3.3Vin	300mA
VBATT	

Lowest on-board consumption is achieved when powering the module from single 3.3V supply. When using split 3.3V/5V supplies the power consumption (and heat dissipation) will rise, this is due to the DC/DC converter efficiency (it decreases when VIN/VOUT ratio rises).

Typical power consumption is between 2-3W.

Ethernet PHY Power-down

If on-board ethernet PHY is not used it can be forced into full powerdown, it requires 3 different setting in PHY registers that force the Copper Interface power-down, RGMII power-down and disable the CLK125 output as well.

Write 0x0800 to register 0 page 0, and 0x0003 to register 16 page 2.

Power saving about 60mW from the PHY power-down, this is only from the PHY IC, Zynq ETH Interface is still in used and clocked, so additional power saving could be achieved by disabling PS ETH as well.

Ethernet PHY clock oscillator can be forced into standby, additional 10mW savings.



USB PHY Power-down

USB PHY can be forced into power down by setting the USB PHY Reset active.



Resets

The system pin called RESIN is mapped to the Zynq POR Reset pin as default. The function of this pin can be changed during the boot process.

Note: If TE0720 is used with a full O/S like linaro/ubuntu, and the internal eMMC or external SD card is mounted as a Linux live file system, then it is not recommended to reset the system by asserting RESIN. RESIN pin function can be changed from POR reset to an interrupt, enabling the O/S to do a proper shut down. Please check System Management Controller section.

Software forced Resets

The SC starts the Zynq with a cascaded JTAG chain bootstrap option after initial power on. If an independent JTAG option is desired then the Zynq should be restarted (force POR), which latches the new bootstrap options. The SC can do this under software control.

A Function not available with SC version 0.2

Peripheral Resets

Some on-board peripherals have separate reset inputs. Those are normally asserted by the SC during initial power-up sequence. After the boot process those reset pins can be controlled via the SC.



SC update for TE0720-02

TE0720 SC can be updated on TE0703 base board (or on custom baseboards).

It is best to check the JTAG configuration with ToolZ to be sure what IC is selected in Chain.

TAG Script												
Open <u>S</u> elect Close Reset	*	Detect	<u>S</u> tate		Run Show Commands Run from File Stop On Error	Check Erase Program SR2 Write JEDEC ID	Load BSDL SAMPLE PRELOAD EXTEST	Program UFM DNA DONE=1 ERASE Reconfig				
	Cable	Chain	TAP/Debug		SVF	SPI	BSDL	FPGA				
D · USB ▲ · JTAG 	477 093		SVF BS	SDL PDL/TCL Board	Module				*			
Properties												
Key	Value											
IDCODE	23727093											
VENDOR	Xilinx											
USERCODE	FFFFFFF											
DNA	000000000000000000000000000000000000000											
Devices Files									~			
Opening device automatically. INF0: Tool2 - Digilent Product Name: JTAG-ONB4 INF0: Tool2 - Digilent Product ID: 50800157 INF0: Tool2 - Vendor Product: TE0703-02												
Messages TC	L Console											
23727093												

Zynq is selected in JTAG, this is normal operational mode. All switches left (ON).

TPD=							ToolZ	N			x
ЛА	G Script							μ <u>ς</u>			0
Open <u>S</u> elect Close Reset	Ţ	Detec	ct <u>S</u> tate			Run Run from F	 Show Commands ile Stop On Error 	Check Erase Program SR2 Write JEDEC ID	Load BSDL SAMPLE PRELOAD EXTEST	Program UFM DNA DONE=1 ERASE Reconfig	
	Cable	Chain	1	TAP/I	Debug		SVF	SPI	BSDL	FPGA	
⊳·USB			SVF	BSDL F	PDL/TCL Boar	d/Module					
▲·JTAG	4043										*
Properties											
Кеу	Key Value										
IDCODE	012BA043										
VENDOR	Lattice Semiconductor										
USERCODE	CC032000										
DNA	C822C01AE8016784										
Devices Files											-
Opening device automatically. INF0: ToolZ - Digilent Product Name: JTAG-ONB4 INF0: ToolZ - Digilent Product ID: 50800157 INF0: ToolZ - Vendor Product: TE0703-02 WARNING: TE0701 in Carrier Controller CPLD JTAG Programming MODE, set 53.3 "JTAGEN" to "ON" to disable!											*
Messages TCL Console											
012BA043											


Only S3.3 is moved to right (OFF) position. TE0703 onboard baseboard controller CPLD is in JTAG chain with USERCODE CC03xxxx

TPD=					ToolZ				x
ЛАТ	Script								0
Open <u>S</u> elect Close Reset	•	Detect	<u>S</u> tate	*	Run Show Commands Run from File Stop On Error	Check Erase Program SR2 Write JEDEC ID	Load BSDL SAMPLE PRELOAD EXTEST	Program UFM DNA DONE=1 ERASE Reconfig	
	Cable	Chain		TAP/Debug	SVF	SPI	BSDL	FPGA	
⊳∙USB ▲∙JTAG 01284	043	-	SVF B	SDL PDL/TCL Board	Module				*
Properties									
Кеу	Value								
IDCODE	012BA043								
VENDOR	Lattice Semiconductor								
USERCODE	E7200201								
DNA	DNA 0822C01499A267AC								
Devices Files									~
INFO: TOOl2 INFO: TOOl2 INFO: TOOl2 WARNING: TO WARNING: TO WARNING: TO	INFO: Tool2 - Digilent Product Name: JTAG-ONB4 INFO: Tool2 - Digilent Product ID: 50800157 INFO: Tool2 - Vendor Product: TE0703-02 WARNING: TE0701 in Carrier Controller CPLD JTAG Programming MODE, set S3.3 "JTAGEN" to "ON" to disable! WARNING: TE0701 in Carrier Controller CPLD JTAG Programming MODE, set S3.3 "JTAGEN" to "ON" to disable!								
Messages TC	CL Console								
				012BA043					

Only S3.2 is moved to right (OFF) position. TE0720 onboard system controller CPLD is in JTAG chain with USERCODE E720xxxx,

TE0703 LED's D1, D2 should be both LIT. If not then it is needed to update the CPLD on TE0703 first, to enable module controller programming.



Board-level Components



Figure 4: Overview: TE0720 Board-level Components

¹ Note: The DDR3 SDRAM size depends on assembly option.



DDR3 SDRAM

Memphis MEM4G16D3EABG-125I DDR3 SDRAM is used which is fully compatible to Micron MT41J256M16. Two RAM devices are used in a fly-by topology configuration with a 32-bit data width.

A Different DDR3 devices may be used on different module derivatives.

Configuration

NN07 D	- C (E. 2)		5					
ZTNQ7 Processing System (5.2)								
Documentation 🛅 IP L	ocation 🏠 Presets							
age Navigator	ODR Configuration							
Zuna Block Decian	👍 📝 Enable DDR							
Lynd block besign	Search: Q-							
S-PL Configuration								
eripheral I/O Pins	Name Name	Select	Description					
	DDR Controller Configuration							
10 Configuration	Memory Type	DDR 3	 Select the type of memory interface/types. Please refer to the TRM for a detailed list of supported memory controllers for Zynq family 					
lock Configuration	Memory Part	MT413256M16 RE-125	Select the desired memory part. For unlisted parts choose "Custom". This will enable user changes in the "Memory Part Configuration" section.					
	Effective DRAM Bus Width	32 Bit	Select the desired data width. Refer to the Thechnical Reference Manual (TRM) for a detailed list of supported DDR data widths.					
DR Configuration	ECC	Disabled	ECC is supported only for data width of 16-bit.					
MC Timing Calculation	Burst Length	8	 Select the burst Length. It refers to the amount of data read/written after a read/write command is presented to the controller 					
to thing concordent	DDR	533.333313	Chose the clock period for the desired frequency. The allowed freq range (200 - 667 MHz) is a function of FPGA part and FPGA speed grade					
terrupts	Internal Vref		The internal Vref used when external resistors are not used on DDR IO supply voltage.					
	·····Operating Temperature (C)	Normal (0-85)	Select the operating temparature					
	Memory Part Configuration							
	Training/Board Details	User Input	x					
	DRAM Training							
	···Write leveling		Provide the Write levelling of DRAM Training. Adjust WR DQS relative to CLK					
	Read gate		Provide the Read gate of DRAM Training. Adjust valid RD DQS window.					
	Read data eye		Provide the Read data eye of DRAM Training. Adjust RD DQS relative to RD data					
	DQS to Clock Delay (ns)							
	····DQS0	0.0	DQS to Clock delay [0] (ns). The daly difference of each DQS path delay subtracted from the clock path delay					
	-DQS1	0.0	DQS to Clock delay [1] (ns). The daly difference of each DQS path delay subtracted from the clock path delay					
	···DQS2	0.0	DQS to Clock delay [2] (ns). The daly difference of each DQS path delay subtracted from the clock path delay					
	DQS3	0.0	DQS to Clock delay [3] (ns). The daly difference of each DQS path delay subtracted from the clock path delay					
	Board Delay (ns)							
	DQ[7:0]	0.0	Board delay [0] (ns). The average of the data midpoint delay, of the data delays associated with a byte lane (DDR_DQ, DDR_DM) averaged with the mid.					
	DQ[15:8]	0.0	Board delay [1] (ns). The average of the data midpoint delay, of the data delays associated with a byte lane (DDR_DQ, DDR_DM) averaged with the mid					
	DQ[23:16]	0.0	Board delay [2] (ns). The average of the data midpoint delay, of the data delays associated with a byte lane (DDR_DQ, DDR_DM) averaged with the mid					
	DQ[31:24]	0.0	Board delay [3] (ns). The average of the data midpoint delay, of the data delays associated with a byte lane (DDR_DQ, DDR_DM) averaged with the mid.					
	Additive Latency (ns)	0	Provide the Additive Latency (ns). Increases the efficiency of the command and data bus for sustainable bandwidths					
			_					

Setting the DDR3 configuration for the TE0720 is straightforward.

Select "Memory Part" as shown in the diagram.

Select "Effective DRAM Bus Width" as 32-bit.

Ensure that "Internal Vref" is disabled.

Set all delays to 0.

Optimal delays are not zero, so it is recommended to load the board initialization file were correct delays are pre-defined.

Manufacturer Documentation

Name	Version	Date
DDR3-settings.jpg	1	2013-06-28 10:21
MEM4G16D3EABG_10.pdf	1	2013-04-06 15:51



e-MMC

Managed NAND - e-MMC is supported by newer version of Xilinx FSBL directly as secondary boot media when FSBL itself is fetched from QSPI Flash.

A special compile flag must be set to enable e-MMC support in FSBL. This flag is not needed for e-MMC support in Linux or U-Boot.

	Version	Notes
FSBL	ISE >= 14.6?	eMMC supported as secondary media
U-Boot		supported but can not format blank media
Linux		fully supported

The e-MMC reset input is connected to the SC and is set normally high (not in reset).

A The eMMC reset input is NOT activated in e-MMC after power is applied. So forcing e-MMC reset low has no effect unless e-MMC command to enable reset is sent.

Format internal eMMC Card (Linux)

Full equipped TE0720-01-*F modules have onboard 4G eMMC card. By default this card not have partitions and not formatted. Below you can see sample eMMC configuration (One primary partition, Linux EXT2 filesystem)

Connect to the board using ssh connection or serial console via J5 mini-USB connector

Execute linux commands to create partition

zynq> fdisk /dev/mmcblk0

The number of cylinders for this disk is set to 117248. There is nothing wrong with that, but this is larger than 1024, and could in certain setups cause problems with: 1) software that runs at boot time (e.g., old versions of LILO) 2) booting and partitioning software from other OSs (e.g., DOS FDISK, OS/2 FDISK)

Command (m for help): n

In command menu press 'n' to create new partition and then Enter.



Command action e extended p primary partition (1-4)

Press 'p' to create primary partition and then Enter.

Partition number (1-4): 1

Press '1' for first partition and then Enter.

First cylinder (1-117248, default 1):

Press Enter to select default value.

Last cylinder or +size or +sizeM or +sizeK (1-117248, default 117248):

Press Enter to select default value.

Command (m for help):

Press 'w' to save changes and exit.

Execute linux command to format partition. To EXT2

zynq> mke2fs /dev/mmcblk0p1

To FAT

zynq> mkdosfs /dev/mmcblk0p1

After formatting eMMC drive is ready to use and will be mounted after next reboot.

To mount it immediately

zynq> mount /mnt/mmc



Ethernet

Overview: Ethernet

TE0720 uses a Marvell Alaska 88E1512 Gigabit Ethernet PHY. PHY Datasheets and documentation if needed are available from Marvell (an NDA is required). The Zedboard uses the same PHY with the only difference being the package. The 88E1512 device is the only Marvell PHY from the 88E15xx series supporting an industrial temperature range and a 1.8V I/O Voltage.

The Ethernet PHY RGMII Interface is connected to the Zynq Ethernet0 PS GEM0 (MIO Pins MIO16..MIO27), I/O Voltage is fixed at 1.8V for HSTL signalling.

The internal regulators of the PHY are not used and all power for the device is supplied from the TE0720 DC-DC supplies.

Cable Diagnostic and VCT

Marvell Alaska PHY devices include a built-in Cable Diagnostic Feature and VCT (Virtual Cable Tester). These functions are available over the MDI interface. More information can be found in the Marvell documentation.

Media Autodetect

Power up defaults enable fiber-copper auto-detection, with fiber being the preferred media. If this setting is not changed the PHY will always transmit on SGMII TX pins, also if link is in copper mode. To disable fiber/SGMII

```
zynq-uboot> mii write 0 0x16 0x12
zynq-uboot> mii write 0 0x14 0x8210
zynq-uboot> mii write 0 0x16 0
```

The above writes select page 20, then disable the auto media detect with PHY reset and then select Page 0 again.

Advanced PHY Features

Marvell Alaska PHY devices include support for PTP and SyncE. In these modes LED and CONFIG will be mapped to different hardware functions. TE0720 System Controller can map those pins to the Zynq PL I/O pins so that all operational modes of the PHY can be utilized.

Temperature sensor

Example how to read temperature with u-boot

```
zynq-uboot> mii write 0 0x16 6
zynq-uboot> mii read 0 0x1b
0C54
zynq-uboot>
```

Write to register 22 selects page 6, read from register 26_6 returns temperature value in lower 8 bits. Temperature in Celsius = $R26_6[7:0] - 25$

PHY Connections

Because the Zynq PS has limited pins (MIO Pins) only RGMII and MDI pins from the PHY are connected directly to the Zynq device. The remaining pins are connected to the SC that provides logic level conversion and interface translation. When the PL is configured those LED pins can optionally forwarded to the PL Fabric. It is also possible to assign the PHY LEDs to the TE0720 on board LED*s.

PHY PIN	Alternate Function	ZYNQ PS	ZYNQ PL	SC	B2B Connector
MDC	-	MIO52	-	yes	-
MDIO	-	MIO53	-	yes	-
LED1		-	XIO	yes	*
LED2		-	XIO	yes	*
LED3	Interrupt	-	-	yes	*
CONFIG		-	-	yes	-
RST	-	-	-	yes	-
RGMII	-	MIO16MIO27	-	no	-
SGMII		-	-	-	yes
Copper		-	-	-	yes

By default the PHY Address is strapped to 0x00. SC is capable of changing it to 0x01 if needed.



SGMII/Fiber



SGMII signal EYE captured using SFP2SMA and 1.5m long SMA cables.

A Marvell PHY is most likely be left in auto-detect mode after system boot, in such case if copper media is not detected SGMII output is enabled and transmitting. If this is not desired the PHY should be programmed to disable SGMII autodetection.



PHY LED Control

The Ethernet PHY LEDs are not directly available on the B2B Connectors.

The SC can however remap the PHY LED signals.

By default the NOSEQ pin is converted to an output pin after the boot process and PHY LED0 is mapped to this B2B pin. During the boot process it is also possible to change this behaviour.

PHY LED0, LED1 and LED2 are also made available to be used in the FPGA fabric where they can be routed to any free FPGA pins.

Signal Name	B2B/FPGA	LED #	PHY default function	
NOSEQ	JM1.	LED0		After boot process PHY LED0 is mapped to NOSEQ
XIO4	M15	LED0	1G/100M: ON=Link, Blink=Activity, OFF=No Link	
XIO5	N15	LED1	100M/10M: ON=Link, Blink=Activity, OFF=No Link	
XIO6	P16	LED2		Note: must be enabled in software

SC rev 0.2 default mapping of Ethernet LED's to B2B and or FPGA Pins

A Marvell PHY LED pins are multipurpose pins with shared and configurable functions.

Default behavior

If Marvell PHY LED control register is not changed during boot process then PHY power up default LED settings apply. Please consult Marvell datasheet for exact features.

PHY LED Demo Design

This demo is for TE0701, for other carrier or custom base board please change user LED mappings as needed.

```
library IEEE;
use IEEE.STD_LOGIC_1164.ALL;
entity PHY_LED_TEST is Port (
    PHY_LED0_IN : in STD_LOGIC; -- forwarded signal from PHY LED[0] output
    PHY_LED1_IN : in STD_LOGIC; -- forwarded signal from PHY LED[1] output
    PHY_LED2_IN : in STD_LOGIC; -- forwarded signal from PHY LED[1] output
    PHY_LED0_OUT : out STD_LOGIC; -- USER I/O Signal in PMOD J5
    PHY_LED1_OUT : out STD_LOGIC; -- USER I/O Signal in PMOD J5
    PHY_LED2_OUT : out STD_LOGIC; -- USER I/O Signal in PMOD J5
    PHY_LED2_OUT : out STD_LOGIC); -- USER I/O Signal in PMOD J5
    end PHY_LED_TEST;
```



```
architecture Behavioral of PHY_LED_TEST is
begin
PHY_LED0_OUT <= PHY_LED0_IN; -- just route LED signal from phy led out to I/O in
PHY_LED1_OUT <= PHY_LED1_IN; -- just route LED signal from phy led out to I/O in
PHY_LED2_OUT <= PHY_LED2_IN; -- just route LED signal from phy led out to I/O in
end Behavioral;
Complete code for PHY LED Demo
NET "PHY_LED0_IN" IOSTANDARD = LVCMOS33;
NET "PHY_LED0_OUT" IOSTANDARD = LVCMOS33;
NET "PHY_LED2_IN" IOSTANDARD = LVCMOS33;
NET "PHY_LED2_OUT" IOSTANDARD = LVCMOS33;
```

```
NET "PHY_LED1_OUT" IOSTANDARD = LVCMOS33;
NET "PHY_LED0_IN" LOC = M15;
NET "PHY_LED1_IN" LOC = N15;
NET "PHY_LED2_IN" LOC = P16;
NET "PHY_LED0_OUT" LOC = AA19;
NET "PHY_LED1_OUT" LOC = Y18;
NET "PHY_LED2_OUT" LOC = AA18;
```

NET "PHY_LED1_IN" IOSTANDARD = LVCMOS33;

Constraint file for TE0720 when used with TE0701 with 3 LED's inserted into into J5 PMOD

Testing of the LED's

Boot normally and break into u-boot, then use impact or other tool to configure FPGA with the LED Demo .bit file. Now you can configure the PHY LED functions and monitor the effects.

```
zynq-uboot>mii write 0x1A 5 0x0010
enable LED2 forwarding to FPGA fabric
zynq-uboot>mii write 0 0x16 3
select Page 3 for Marvell PHY
zynq-uboot>mii write 0 0x10 0x1bbb
This will make all 3 LED's to blink
zynq-uboot>mii write 0 0x10 0x1888
This forces all LED's to OFF state
zynq-uboot>mii write 0 0x10 0x1999
```



This forces all LED's to ON state

```
zynq-uboot>mii write 0 0x10 0x1730
```

This configures LED0 as LINK, LED1 as Activity and LED2 as 10Mbit

LED polarity is programmable, default is low(0)=> LED ON

zynq-uboot>mii write 0 0x11 0x4415

to change polarity of all LEDs

Design files and ready to use bit file (for TE0701-J5) are available from the download area.



On-board LEDs

Overview: On-board LEDs

There are 3 on-board LEDs, with two of them connected to the System Management Controller and one to the Zynq PL (Done pin).

Name	Color	Connected to:	Default mapping:
LED1	Green	SC	PL MIO[7]
LED2	Red	SC	System Controller Status LED
LED3	Green	Zynq PL	FPGA Done - active low

LED1 GREEN

Is mapped to MIO7 after power up. After the Zynq PS has booted it can change the mapping of this LED. If SC can not enable power to the Zynq then this LED will remain under SC control. It is available to the user only after the power supplies have stabilized and the POR reset to the Zynq is released.

LED2 RED

Is used by the SC as global status LED. The SC can show status information on this LED. Vin power is not required.

LED3 GREEN (FPGA Done)

This green LED is connected to the FPGA Done pin which has an active low state. As soon as the Zynq is powered and the 3.3V I/O voltage is enabled, this LED will illuminate. This indicates that the Zynq PL is not configured. Once the Zynq PL has been configured the LED will go off.

During normal operation when the Zynq PL has been configured, the LED can be controlled from the FPGA fabric. Control of the LED in a user design requires the use of Xilinx startup primitive rather than a normal I/O primitive. If the startup primitive is not used then the LED will go off after configuration and remain off irrespectively of the user design. This LED can not be controlled by the SC.

A This LED will not operate if the SC can not power on the 3.3V output rail that also powers the 3.3V circuitry on the module.

LED Status Codes

LED1	LED2	LED3		Description
OFF	OFF	ON	Fatal error on carrier board	This combination after power up is only possible in no sequencing compatibility mode were 3.3Vout is supplied externally. The 1.0V and 1.8V DC-DC supplies are forced on (NOSEQ=1), and the SC is not able to start (3.3Vin below 2.1V). This should never happen if the external power supplies are OK.
OFF	ON	OFF		



LED1	LED2	LED3		Description
			VIN missing	3.3Vin is present, but the DC-DC supplies are not powered or 3.3Vin is below 3.05V. If the LEDs stay on in this state then 3.3Vout is not turned on, and the Zynq is kept in the POR state.
OFF	1/2 Blink Fast 4 Hz	ON	ОК	Zynq boot from SPI Flash has started.
OFF	1/2 Blink Slow 1 Hz	ON	ОК	Zynq boot from SD Card has started.
MIO7 or user controlled function	Blink or user controlled function	OFF	ОК	LED3 goes off when the FPGA is configured. NOTE: The FPGA design can control this LED too, so it may remain ON or be flashing when the FPGA is configured.
ON	Slow blink 0.5Hz, 1/8 on, 7/8 off	ON or OFF	Powerdown	EN1 input to the module is low. If sequencing is enabled in this mode, then all power supplies on the module are OFF.
ON	ON	ON	Reset	Powered, RESIN input is active low.



TODO: MEMS

In linux MEMS data can be read using device files

cat /sys/bus/i2c/devices/2-001e/iio\:device1/in_magn_x_raw current magnetometer X value cat /sys/bus/i2c/devices/3-0018/iio\:device0/in_accel_x_raw current accelerometer X value



RTC

An Intersil temperature compensated real time clock IC ISL1202M is used for timekeeping. Battery voltage must be supplied to the module from the main board.

Battery backed registers are accessed at I2C slave address 1101111x

General purpose RAM is accessed at I2C slave address 1010111x

This RTC IC is supported in Linux so it can be used as hwclock device.

RTC data also can be read using device file

cat /sys/bus/i2c/devices/2-006f/rtc/rtc0/time



USB

USB HS PHY, USB3320 from Microchip (previously SMSC) is used on the TE0720 module. This is the recommended USB PHY for Zynq devices. SMSC offers a design review service for customer schematic and PCB layouts after registration on their website. Note: This design check service does not list USB PHY devices (only LAN Devices), but the SMSC team will consider and reply to design review requests for USB PHY devices too.

ZYNQ Pins	PHY Pins	B2B Name	Notes
MIO3039	ULPI	-	Zynq USB0 MIO pins are connected to the PHY
	REFCLK	-	52MHz from MEMS oscillator
	REFSEL[02]	-	000 GND, select 52MHz reference Clock
	RESETB	-	Connected to SC
	CLKOUT	-	Connected to 1.8V selects reference clock operation mode
	DP,DM	OTG-D_N, OTG-D_N	USB Data lines
	CPEN	VBUS_V_EN	External USB power switch active high enable signal
	VBUS	USB-VBUS	Connect to USB VBUS via a series resistor. Check reference schematic
	SPK_L	-	Connected to SC
	SPK_R	-	Connected to SC
USB0_OC	-	-	Over current detection from external power switch. If desired it can be muxed to an MIO or FPGA I/O pin via EMIO

The schematic for the USB connector and required components is different depending on the USB usage. USB standard A or B connectors can be used for Host or Device modes. A Mini USB connector can be used for USB Device mode. A USB Micro connector can be used for Device mode, OTG Mode or Host Mode.

A The same schematic can not support all possible modes and be fully USB Specification Compliant.



SPI Flash

Programming

TE0720-02 uses Spansion S25FL256S0 Flash that is fully supported by all Xilinx Tools.

TE0720-01 uses Winbond W25Q256 Flash that is supported by Xilinx SDK 2013.4 and 2014.1 (it is not supported by Impact 14.7 or Vivado Programmer 2014).



Board-level Interfaces



Figure 5: Overview: TE0720 Board-level Interfaces

¹ Note: The DDR3 SDRAM size depends on assembly option.





Zynq SoM: Multiplexed I/O (MIO) Assignments

Bank	B2B I/O (LVDS Pairs)	VCC I/O Bank	I/O Bank VREF
MIO 0	8	3.3V Fixed	n/a
MIO 1	6	1.8V Fixed	0.9V Fixed
B13	50 (24)	1.2 - 3.3V User Adj.	If a user I/O is used as a Vref pin then the pins available will be reduced.
B33	18 (9)	1.2 - 3.3V User Adj.	User supplied, extra pin
B34	36 (18)	1.5 - 3.3V User Adj.	User supplied, extra pin
B35	48 (24)	1.2 - 3.3V User Adj.	If used need supply to regular I/O pins, reduces I/O count
Total	166 (75)	-	-

MIO Bank 1 pins are used by the SDIO0 core which is required for the SD card boot. A bootable SD card must be connected to these pins.

MIO Bank 1 pins are powered from 1.8V. So if using a normal SD card then an external level shifter is required.

MIO Bank 0 Usage

There are 8 PS MIO pins from Bank 0 available. They can be configured to be connected to different Zynq PS Peripherals.

MIOO	MIO9	MIO10	MIO11	MIO12	MIO13	MIO14	MIO15	Comment
GPIO	GPIO	I2C0 SCL	I2C0 SDA	UART1	UART1	UART0	UART0	2x UART + I2C (Recommended configuration)
GPIO	GPIO	TDI	TDO	тск	TMS	UART0	UART0	ARM Debug with UART
GPIO	GPIO	I2C0 SCL	I2C0 SDA	CAN1	CAN1	UART0	UART0	UART + CAN + I2C
GPIO	GPIO	CAN0	CAN0	UART1	UART1	UART0	UART0	2x UART + CAN
GPIO	GPIO	CAN0	CAN0	CAN1	CAN1	UART0	UART0	UART + 2x CAN
GPIO	GPIO	I2C0	I2C0	I2C1	I2C1	UART0	UART0	UART + 2x I2C
GPIO	GPIO	GPIO	GPIO	GPIO	GPIO	GPIO	GPIO	8 bit GPIO
GPIO	GPIO	SDIO1	SDIO1	SDIO1	SDIO1	SDIO1	SDIO1	SD/SDIO (not bootable)
GPIO	GPIO	SD	SD	SD	GPIO	UART0	UART0	SD/MMC in 1 bit mode with UART
GPIO	GPIO	SPI1	SPI1	SPI1	SPI	UART0	UART0	SPI and UART
QSPI1	QSPI	QSPI1	QSPI1	QSPI1	QSPI1	UART0	UART0	Quad SPI and UART

Example MIO configuration for Bank 0 User I/O. When a PS peripheral is not mapped to a MIO pin it can be used via the Zynq FPGA PL Fabric by using the EMIO interface (Quad SPI is not available via EMIO).



Compatibility with TE07xx series

To be compatible with TE0770 and other TE07xx series modules that have gigabit transceivers, the B34 pins that are dedicated pins on those modules should not be used.

I2C Peripherals

All on-board I2C devices are on a shared bus connected to the System Management Controller. This bus is not available directly to the Zynq PS when the PL is not configured.

It is recommended to map PS I2C1 via EMIO to this I2C bus.

Binary	Hex	HEX >> 1	Device	Notes
1101111x	DE	6F	RTC Registers	
1010111x	A0	57	Battery backup RAM	in RTC IC
0011110x	3C	1E	Magnetometer	MEMS IC
0011000x	30	18	Accelerometer	MEMS IC
0100001x	42	20	System Controller	Emulated I2C GPIO Extender
		21	System Controller	Emulated I2C GPIO Extender
		22	Carrier Controller	on TE0701
		23	Carrier Controller	on TE0701
0111001x	72	39	ADV7511 Registers	on TE0701
0111000x	70	38	ADV7511 Packet Memory	on TE0701, can be changed
0111111x	7E	3F	ADV7511 EDID Memory	on TE0701, can be changed
0111100x	78	3C	ADV7511 CEC Memory	on TE0701, can be changed

I2C Testing with U-Boot

U-Boot can be used as simple I2C test tool.

zynq-uboot> i2c probe 0 7f

Valid chip addresses: 1E 20 21 22 38 39 3C 3E 3F 57 6F

Example I2C address scan, RTC, MEMS, ADV7513, System Controller and Carried Controller addresses are detected.



High-Speed I/O

TE0720 module is based on the Zynq 7020 which doesn't have any Gigabit transceivers. However in many cases it is possible to use serial links up to 1.25 GBit/s using FPGA I/O resources. Those serial interfaces can be implemented in any FPGA I/O bank when paying attention to the clocking requirements (clock regions).

SGMII (1.25 Gbit/s) can be implemented with FPGA I/O pins as described in Xilinx XAPP523.

High-speed serial interface ADC converters can be used as described in Xilinx XAPP524.

SGMII (SFP copper or fiber) can be used directly with the Ethernet PHY, as the SGMII pins are available in JM3.



Board-to-Board Connectors

These connectors are hermaphroditic. Odd pin numbers on the module are connected to even pin numbers on the baseboard and vice versa.

GigaZee uses three Samtec Razor Beam LSHM connectors (TOP, BOTTOM and LEFT) on the bottom side.

- Top and Bottom:LSHM-150-04.0-L-DV-A-S-K-TR (100 pins, "50" per row)
- Left: LSHM-130-04.0-L-DV-A-S-K-TR (60 pins, "30" per row)

When using the same type on baseboard the mating height is 8mm. Other mating heights are possible by using connectors with a different height:

Connector on baseboard	Mating height
LSHM-1x0-02.5-L-DV-A-S-K-TR	6.5 mm
LSHM-1x0-03.0-L-DV-A-S-K-TR	7.0 mm
LSHM-1x0-04.0-L-DV-A-S-K-TR	8.0 mm
LSHM-1x0-06.0-L-DV-A-S-K-TR	10.0mm

Other connectors can be assembled on the module on request.

The LSHM connector speed rating depends on the stacking height; please see the following table:

Stacking height	Speed rating
12 mm, Single-Ended	7.5 GHz / 15 Gbps
12 mm, Differential	6.5 GHz / 13 Gbps
5 mm, Single-Ended	11.5 GHz / 23 Gbps
5 mm, Differential	7.9 GHz / 14 Gbps

Mechanical Ratings:

- Shock: 100G, 6 ms Sine
- Vibration: 7.5G random, 3 hours 3 axis

Manufacturer Documentation:

Name	Version	Date
LSHM-1XX-XX.X-X-DV-A-X-X-TR-FOOTPRINT(1).pdf	1	2013-11-28 16:54
LSHM-1XX-XX.X-XX-DV-A-X-X-TR-MKT.pdf	1	2013-11-28 16:56
TC09232523_report_Rev_2_qua.pdf	1	2013-11-28 16:55



Name	Version	Date
hsc-report_lshm-lshm-05mm_web.pdf	1	2013-11-28 16:56
lshm_dv.pdf	1	2013-11-28 16:56
tc09292611_qua(1).pdf	1	2013-11-28 16:55



Pinout

Connector left

Edit Document

Pin	Net	Туре	Bank	FPGA
1	SOUT_N	SGMII_TX		
3	SOUT_P	SGMII_TX		
5	GND			
7	B34_L7_P	DIFFIO	34	J18
9	B34_L7_N	DIFFIO	34	K18
11	GND			
13	B34_L2_P	DIFFIO	34	J16
15	B34_L2_N	DIFFIO	34	J17
17	GND			
19	B34_L4_P	DIFFIO	34	L17
21	B34_L4_N	DIFFIO	34	M17
23	GND			
25	B34_L5_P	DIFFIO	34	N17
27	B34_L5_N	DIFFIO	34	N18
29	GND			
31	B34_L12_P	DIFFIO_CC	34	L18
33	B34_L12_N	DIFFIO_CC	34	L19
35	GND			
37	B34_L8_P	DIFFIO	34	J21
39	B34_L8_N	DIFFIO	34	J22
41	B34_L9_P	DIFFIO	34	J20
43	B34_L9_N	DIFFIO	34	K21
45	GND			
47	OTG D+	DIFFIO		
49	OTG D-	DIFFIO		
51	OTG ID	1		
53	VBUS_V_EN	0		
55	USB_VBUS	I		
57	B34_L22_P	DIFFIO	34	R19



59	B34_L22_N	DIFFIO	34	T19
2	SIN_N	SGMII_RX		
4	SIN_P	SGMII_RX		
6	GND			
8	B34_L1_P	DIFFIO	34	J15
10	B34_L1_N	DIFFIO	34	K15
12	GND			
14	B34_L18_P	DIFFIO	34	P20
16	B34_L18_N	DIFFIO	34	P21
18	GND			
20	B34_L20_P	DIFFIO_CC	34	P17
22	B34_L20_N	DIFFIO_CC	34	P18
24	GND			
26	B34_L10_P	DIFFIO	34	L21
28	B34_L10_N	DIFFIO	34	L22
30	GND			
32	B34_L13_P	DIFFIO_CC	34	M19
34	B34_L13_N	DIFFIO_CC	34	M20
36	GND			
38	B34_L21_P	DIFFIO	34	T16
40	B34_L21_N	DIFFIO	34	T17
42	B34_L15_P	DIFFIO	34	M21
44	B34_L15_N	DIFFIO	34	M22
46	GND			
48	B34_L17_P	DIFFIO	34	R20
50	B34_L17_N	DIFFIO	34	R21
52	B34_L23_P	DIFFIO	34	R18
54	B34_L23_N	DIFFIO	34	T18
56	B34_VREF	IO_VREF	34	M16/P15
58	B34_L14_P	DIFFIO_CC	34	N19
60	B34_L14_N	DIFFIO_CC	34	N20

Connector top

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Pin	Net	Туре	Bank	FPGA	
1	VCCIO34	I/O Supply	34		
3	VCCIO34	I/O Supply	34		
5	VCCIO33	I/O Supply	33		
7	VCCIO13	I/O Supply	13		
9	VCCIO13	I/O Supply	13		
11	B33_L7_P	DIFFIO	33	AA22	
13	B33_L7_N	DIFFIO	33	AB22	
15	B33_L8_P	DIFFIO	33	AA21	
17	B33_L8_N	DIFFIO	33	AB21	
19	1.5V	0			
21	B33_L11_P	DIFFIO_CC	33	Y19	
23	B33_L11_N	DIFFIO_CC	33	AA19	
25	B33_L12_P	DIFFIO_CC	33	Y18	
27	B33_L12_N	DIFFIO_CC	33	AA18	
29	B33_VREF	IO_VREF	33	V19/V15	
31	B33_L17_P	DIFFIO	33	AA17	
33	B33_L17_N	DIFFIO	33	AB17	
35	B33_L18_P	DIFFIO	33	AA16	
37	B33_L18_N	DIFFIO	33	AB16	
39	GND				
41	B13_L7_P	DIFFIO	13	AA12	
43	B13_L7_N	DIFFIO	13	AB12	
45	B13_L8_P	DIFFIO	13	AA11	
47	B13_L8_N	DIFFIO	13	AB11	
49	GND				
51	B13_L11_P	DIFFIO_CC	13	AA9	
53	B13_L11_N	DIFFIO_CC	13	AA8	
55	B13_L9_P	DIFFIO	13	AB10	
57	B13_L9_N	DIFFIO	13	AB9	
59	GND				
61	B13_L20_P	DIFFIO	13	T4	
63	B13_L20_N	DIFFIO	13	U4	
65	B13_L17_P	DIFFIO	13	AB7	



67	B13_L17_N	DIFFIO	13	AB6
69	GND			
71	B13_L16_P	DIFFIO	13	AB5
73	B13_L16_N	DIFFIO	13	AB4
75	B13_L18_P	DIFFIO	13	Y4
77	B13_L18_N	DIFFIO	13	AA4
79	GND			
81	B13_L15_P	DIFFIO	13	AB2
83	B13_L15_N	DIFFIO	13	AB1
85	B13_L21_P	DIFFIO	13	V5
87	B13_L21_N	DIFFIO	13	V4
89	B13_IO25	Ю	13	U7
91	VREF_JTAG	O 3.3V		
93	TMS	JTAG	0	
95	TDI	JTAG	0	
97	TDO	JTAG	0	
99	тск	JTAG	0	
2	VIN	Power input		
2	VIN	Power input		
2 4 6	VIN VIN VIN	Power input Power input Power input		
2 4 6 8	VIN VIN VIN	Power input Power input Power input		
2 4 6 8 10	VIN VIN VIN VIN 3.3V	Power input Power input Power input O		
2 4 6 8 10	VIN VIN VIN VIN 3.3V	Power input Power input Power input O O		
2 4 6 8 10 12 14	VIN VIN VIN VIN 3.3V 3.3V B33 L4 P	Power input Power input Power input Oocologies DIFFIO	33	W20
2 4 6 8 10 12 14 16	VIN VIN VIN VIN 3.3V 3.3V B33_L4_P B33_L4_N	Power input Power input Power input Oocologies DIFFIO DIFFIO	33	W20 W21
2 4 6 8 10 12 14 16 18	VIN VIN VIN VIN 3.3V 3.3V B33_L4_P B33_L4_N RESIN	Power input Power input Power input Oocol DIFFIO DIFFIO Reset input	33	W20 W21
2 4 6 8 10 12 14 16 18 20	VIN VIN VIN VIN 3.3V 3.3V B33_L4_P B33_L4_N RESIN GND	Power input Power input Power input O O DIFFIO DIFFIO Reset input	33	W20 W21
2 4 6 8 10 12 14 16 18 20 22	VIN VIN VIN VIN 3.3V 3.3V B33_L4_P B33_L4_N RESIN GND B33_L13_P	Power input Power input Power input Ooconstant OIFFIO DIFFIO Reset input DIFFIO_CC	33 33 33	W20 W21 W17
2 4 6 8 10 12 14 16 18 20 22 24	VIN VIN VIN VIN 3.3V 3.3V 3.3V B33_L4_P B33_L4_N RESIN GND B33_L13_P B33_L13_N	Power input Power input Power input O O DIFFIO DIFFIO Reset input DIFFIO_CC DIFFIO_CC	33 33 33 33 33	W20 W21 W17 W18
2 4 6 8 10 12 14 16 18 20 22 24 24 26	VIN VIN VIN VIN 3.3V 3.3V 3.3V B33_L4_P B33_L4_N RESIN GND B33_L13_P B33_L13_N B33_L13_N	Power input Power input Power input O O O DIFFIO DIFFIO Reset input DIFFIO_CC DIFFIO_CC DIFFIO_CC	33 33 33 33 33 33	W20 W21 W17 W18 W16
2 4 6 8 10 12 14 16 18 20 22 24 22 24 26 28	VIN VIN VIN VIN 3.3V 3.3V 3.3V 3.3V B33_L4_N B33_L4_N GND B33_L13_P B33_L13_N B33_L14_N	Power input Power input Power input O O DIFFIO DIFFIO Reset input DIFFIO_CC DIFFIO_CC DIFFIO_CC	33 33 33 33 33 33 33	W20 W21 W21 W17 W18 W16 Y16
2 4 6 8 10 12 14 16 18 20 22 24 22 24 26 28 30	VIN VIN VIN VIN 3.3V 3.3V 3.3V 3.3V 3.3V 3.3 4 3.3 4 3.3 4 3.3 4 5 3 3 4 4 5 3 3 4 4 5 3 3 4 4 5 3 4 4 5 3 4 4 5 5 5 5	Power input Power input Power input O O O DIFFIO DIFFIO Reset input DIFFIO_CC DIFFIO_CC DIFFIO_CC	33 33 33 33 33 33 33	W20 W21 W21 W17 W18 W16 Y16
2 4 6 8 10 12 14 16 18 20 22 24 22 24 26 28 30 32	VIN VIN VIN VIN 3.3V 3.3V 3.3V 3.3V 3.3V 3.3 4 3.3 4 3.3 4 3.3 4 5 3 3 4 4 5 3 3 4 4 5 3 3 4 1 4 5 3 3 4 1 4 5 7 5 7 6 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	Power input Power input Power input O O O DIFFIO DIFFIO MEREI DIFFIO_CCC DIFFIO_CCC DIFFIO_CCC	33 33 33 33 33 33 33 33 33	 W20 W21 W21 W17 W18 W16 Y16 Y16 U12



36	B13_L6_P	DIFFIO	13	U10
38	B13_L6_N	DIFFIO	13	U9
40	GND			
42	B13_L1_P	DIFFIO	13	V10
44	B13_L1_N	DIFFIO	13	V9
46	B13_L12_P	DIFFIO_CC	13	Y9
48	B13_L12_N	DIFFIO_CC	13	Y8
50	GND			
52	B13_L14_P	DIFFIO_CC	13	AA7
54	B13_L14_N	DIFFIO_CC	13	AA6
56	B13_L13_P	DIFFIO_CC	13	Y6
58	B13_L13_N	DIFFIO_CC	13	Y5
60	GND			
62	B13_L4_P	DIFFIO	13	V12
64	B13_L4_N	DIFFIO	13	W12
66	B13_L3_P	DIFFIO	13	W11
68	B13_L3_N	DIFFIO	13	W10
70	GND			
72	B13_L10_P	DIFFIO	13	Y11
74	B13_L10_N	DIFFIO	13	Y10
76	B13_L2_P	DIFFIO	13	V8
78	B13_L2_N	DIFFIO	13	W8
80	GND			
82	B13_L23_P	DIFFIO	13	V7
84	B13_L23_N	DIFFIO	13	W7
86	B13_L24_P	DIFFIO	13	W6
88	B13_L24_N	DIFFIO	13	W5
90	GND			
92	B13_L19_P	DIFFIO	13	R6
94	B13_L19_N	DIFFIO	13	Т6
96	B13_L22_P	DIFFIO	13	U6
98	B13_L22_N	DIFFIO	13	U5
100	B13_IO0	ю	13	R7



Connector bottom

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Pin	Net	Туре	Bank	FPGA
1	VIN	Power input		
3	VIN	Power input		
5	VIN	Power input		
7	NOSEQ	input		
9	VCCIO35	I/O Supply		
11	VCCIO35	I/O Supply		
13	3.3VIN	Power input		
15	3.3VIN	Power input		
17	MIO45	MIO	501	В9
19	MIO44	MIO	501	E13
21	MIO43	MIO	501	B11
23	MIO42	MIO	501	D8
25	MIO41	MIO	501	C8
27	MIO40	MIO	501	E14
29	GND			
31	B35_L16_N	DIFFIO	35	C22
33	B35_L16_P	DIFFIO	35	D22
35	B35_L24_N	DIFFIO_ADC	35	G22
37	B35_L24_P	DIFFIO_ADC	35	H22
39	1.8V	0		
41	B35_L18_N	DIFFIO_ADC	35	B22
43	B35_L18_P	DIFFIO_ADC	35	B21
45	B35_L15_N	DIFFIO_ADC	35	A22
47	B35_L15_P	DIFFIO_ADC	35	A21
49	B35_L22_N	DIFFIO_ADC	35	G21
51	B35_L22_P	DIFFIO_ADC	35	G20
53	GND			
55	B35_L17_N	DIFFIO_ADC	35	D21
57	B35_L17_P	DIFFIO_ADC	35	E21
59	B35_L13_N	DIFFIO_CC	35	B20
61	B35_L13_P	DIFFIO_CC	35	B19



63	GND			
65	B35_L14_N	DIFFIO_CC	35	C20
67	B35_L14_P	DIFFIO_CC	35	D20
69	B35_L4_N	DIFFIO	35	G16
71	B35_L4_P	DIFFIO	35	G15
73	GND			
75	B35_L12_N	DIFFIO_CC	35	C19
77	B35_L12_P	DIFFIO_CC	35	D18
79	VBAT	VBAT input		
81	B35_L20_N	DIFFIO_ADC	35	F19
83	B35_L20_P	DIFFIO_ADC	35	G19
85	MIO15	MIO	500	E6
87	MIO0	MIO	500	G6
89	GND			
91	MIO9	MIO	500	C4
93	MIO11	MIO	500	B4
95	MIO10	MIO	500	G7
97	MIO13	MIO	500	A6
99	MIO12	MIO	500	C5
2	GND			
4	PHY_MDI0_P	DIFFIO		
6	PHY_MDI0_N	DIFFIO		
8	GND			
10	PHY_MDI1_P	DIFFIO		
12	PHY_MDI1_N	DIFFIO		
14	NC			
16	PHY_MDI2_P	DIFFIO		
18	PHY_MDI2_N	DIFFIO		
20	GND			
22	PHY_MDI3_P	DIFFIO		
24	PHY_MDI3_N	DIFFIO		
26	GND			
28	EN1	I		
30	PGOOD	0		



32	MODE	IO		
34	GND			
36	B35_L10_N	DIFFIO_ADC	35	A19
38	B35_L10_P	DIFFIO_ADC	35	A18
40	B35_L9_N	DIFFIO_ADC	35	A17
42	B35_L9_P	DIFFIO_ADC	35	A16
44	GND			
46	B35_L7_N	DIFFIO_ADC	35	B15
48	B35_L7_P	DIFFIO_ADC	35	C15
50	B35_L2_N	DIFFIO_ADC	35	D17
52	B35_L2_P	DIFFIO_ADC	35	D16
54	GND			
56	B35_L8_N	DIFFIO_ADC	35	B17
58	B35_L8_P	DIFFIO_ADC	35	B16
60	B35_L21_N	DIFFIO_ADC	35	E20
62	B35_L21_P	DIFFIO_ADC	35	E19
64	GND			
66	B35_L11_N	DIFFIO_CC	35	C18
68	B35_L11_P	DIFFIO_CC	35	C17
70	B35_L23_N	DIFFIO	35	F22
72	B35_L23_P	DIFFIO	35	F21
74	GND			
76	B35_L5_N	DIFFIO_ADC	35	E18
78	B35_L5_P	DIFFIO_ADC	35	F18
80	B35_L3_N	DIFFIO_ADC	35	D15
82	B35_L3_P	DIFFIO_ADC	35	E15
84	GND			
86	B35_L6_N	DIFFIO	35	F17
88	B35_L6_P	DIFFIO	35	G17
90	GND			
92	MIO14	MIO	500	B6
94	B35_L1_N	DIFFIO_ADC	35	E16
96	B35_L1_P	DIFFIO_ADC	35	F16
98	B35_L19_N	DIFFIO	35	H20



100	B35_L19_P	DIFFIO	35	H19



Technical Specifications



TE0720 Board Dimensions & Attributes

Dimensions

- Module size: 50 mm × 40 mm
- Mating height with standard connectors: 8mm
- PCB thinkness: 1.6mm
- highest part on PCB: approx. 2.5mm. Please download the step model for more exact numbers.

All dimensions are shown in mm.





B2B numbers when looking from top onto carrier board will have odd and even numbers swapped.


Power Supplies

Input	Voltage range +/-10%	Connector current rating
Vin	3.3 V ÷ 5.5 V	max. 8 A
Vin 3.3V	3.3 V	max. 2 A

Vin and Vin 3.3V can be connected to the same source (3.3 V).

Temperature Ranges

Commercial grade modules	0 °C ÷ +70 °C
Industrial grade modules	-40 °C ÷ +85 °C

A Depending on the customer design, additional cooling might be required.

Weight

16.2 g	without bolts	
22.4	with bolts screwed to the module	



TE0720 Schematic

The schematic is available for download here: TE0720 (GigaZee) Schematic



Carrier Boards for TE0720

TE0701 Carrier Board

The documentation on the TE0701 Carrier Board can be found in the TE0701 Carrier Board User Manual. Moreover, in the following sections is described how the TE0701 Carrier Board can be customized by the Zynq FPGA via the onboard I2C bus and how the interfacing of the TE0701 peripherals is accomplished from the TE0720's point of view.

Configuring FMC Power Supply Voltage on TE0701 via I2C (CPLD Firmware Rev 0.1)

The FMC power supply on the TE0701 Carrier Board (i.e., FMC_VADJ) is user programmable via I2C. More precisely, the three output voltage select lines VS0 to VS2 of the Enpirion EN5335QI DC-DC converter with 3-pin programmable voltage output are mapped to the CPLD's "I2C-to-GPIO Port Expander" (VID0=GPIO_output[4] => VS0, VID1=GPIO_output[5] => VS1, VID2=GPIO_output[6] => VS2) 8-bit control register, which can be programmed via the dedicated board-to-board I2C bus (HDMI_SCL, HDMI_SDA) on the I2C slave address 0x22:

Bit	Mapping	Description for Output/Write	
0	PHY_LED2	Enable(=1) / disable(=0) yellow LED of PHY on TE0701	0b0
1		reserved	0b0
2		reserved	0b0
3	PG_C2M	signal to FMC connector	0b0
4	VID0	= VS0	0b0
5	VID1	= VS1	0b0
6	VID2	= VS2	0b0
7	EN_FMC	Enable(=1) / disable(=0) FMC_VADJ voltage	0b0

Table 2: Pin assignments of the 8-bit "I2C-to-GPIO Port Expander" Control Register

VID [2:0]	FMC_VADJ Value
0 (000)	3.3V
1 (001)	2.5V
2 (010)	1.8V
3 (011)	1.5V
4 (100)	1.25V
5 (101)	1.2V
6 (110)	0.8V



VID [2:0]	FMC_VADJ Value
7 (111)	reserved

 Table 3: VID is the digitally programmable value for the FMC_VADJ

Example: To enable (EN_FMC=1) and set FMC_VADJ to 3.3V (VID[2:0]=000) write 0x80 to I2C address 0x22.

The most significant bit of the 8-bit GPIO register (see Table 2) is directly routed to the enable input of the Enpirion EN5335QI DC-DC converter, which is disabled by default.

Reading I2C-to-GPIO Status Register on TE0701 CPLD (CPLD Firmware Rev 0.1)

The CPLD's 8-bit "I2C-to-GPIO Port Expander" status register can be read via I2C bus (HDMI_SCL, HDMI_SDA) on the I2C slave address 0x22:



In U-Boot a simple I2C test tool can be used (see TE0720 User Manual | I2C Addresses for more details):

- The I2C command "i2c command" can be used to show all devices on the I2C bus.
- To read, e.g., register 0 from I2C device on address 0x22, the command "i2c md 0x22 0" is used. **Note**: Only one 8-bit status register is available on the TE0720 CPLD



<u>Example</u>: Corresponding to the following mapping of the TE0701 CPLD's status register, the returned register content (0x19=0b00011001) can be interpreted as follows (from LSb upwards): no FMC module inserted (FMC_RSNT#=1), power ok signal due to disabled FMC power supply off (POK_FMC=0), SD card is inserted (SD_DETECT#=0), SD card write protection is enabled (SD_WP=1) and the output load on the USB port has not been exceeded (USB_OC#=1).

Bit	Mapping	Description for Output/Write
0	FMC_RSNT#	FMC module inserted? yes=0, no=1
1	POK_FMC	"Power ok" signal from the Enpirion EN5335QI DC-DC converter (see TE0720 User Manual Carrier Boards for TE0720 for more details)
2	SD_DETECT#	SD Card inserted? yes=0, no=1
3	SD_WP	Write protection on SD Card enabled? yes=1, no=0
4	USB_OC#	Over current (OC) output of the TPS2051 that limits the output current of the Micro USB port and is pulled low, when the output load exceeds the current-limit threshold (see TE0701 Carrier Board User Manual Configuring Power Supply of the Micro USB Connector for more details).
5		reserved
6		reserved
7		reserved



HDMI Interface of TE0720 on TE0701 Carrier Board

	Zynq FPGA I/O Pins	Notes
HDMI_CLK	N20	
HDMI_DE	N19	
HDMI_VS	T19	
HDMI_HS	R19	
HDMI_D0	T18	
HDMI_D1	R18	
HDMI_D2	R21	
HDMI_D3	R20	
HDMI_D4	M22	
HDMI_D5	K21	
HDMI_D6	M21	
HDMI_D7	J20	
HDMI_D8	T17	
HDMI_D9	J22	
HDMI_D10	T16	
HDMI_D11	J21	
SDA	W21	
SCL	W20	
Interrupt	AA17	
CEC_CLK	AB16	FPGA should emit some suitable clock on this pin if CEC feature is needed
CT_HPD	AB17	Drive high for normal operation
LS_OE	AA16	Drive high for normal operation



TE0720 with TE0603 Carrier

TE0603 was not designed for the TE07xx series, so many new functions are not available. TE0720 will be in "no power sequencing mode" when inserted into a TE0603 baseboard. For proper operation VCCIO must be 3.3V and supplied by the TE0603. To enable this place a jumper to short pins 1 and 2 in pin header J2.

TE0603 before Revision -03 please remove R13 or TE0720 will not boot at all. TE0603-03 do not need a fix.

Normal boot procedure; all LEDs are on as long as reset is active. At reset deactivation; green LED2 goes off and very quickly after that green LED3 goes off indicating that the FSBL has loaded the FPGA bitstream (DONE=1). Red LED1 is blinking fast; this is status indication that QSPI boot mode is selected.

Functions available with TE0603

TE0720 Function	TE0603	Description and notes	
USB	no	Missing 3rd connector on TE0603	
ETH	yes, RJ45	There are extra 50 ohm resistors not needed for TE0720	
JTAG	Yes, J5 or J6	With external JTAG Adapter	
SD Boot	no	Missing pins and SD card level shifter	
UART0 MIO14,15	yes	With external logic level USB UART adapter, pins J3 Pin 37 and 24 - default bootloader and Linux console	
-	microSD	Not connected to usable pins on the TE0720	
SDIO	J11	Possible via EMIO only with PMOD-SD adapter not connected to MIO pins	
MIO0 pins	pin header	yes, J3	
FPGA PL I/O	LEDs	EMIO or FPGA controlled	
MIO1 pins	yes, J4	4 pins available in J14 (1.8V VCCIO), 2 pins connected to RJ45 LEDs	

Ethernet will not work in 1000M mode with long brand X cable. Use either a short good quality cable or remove 8 termination resistors for the ETH PHY on the TE0603. Please be aware that TE0600 modules require those terminations, so this modification is only for TE0720 usage.

This video shows how LED1 and LED2 can be connected (using the System Controller) to the Ethernet PHY, and how the indicated status changes when swapping from a "bad" cable to a "good" cable.



UART Console

TE0720 standard flash image uses UART0 for console, baudrate 115200, mapped to MIO pins 14, 15. Those pins are available at J3 pins 24, 37.



Digilent PmodUSBUART connected to TE0603 for MIO14,MIO15.



Carrier Board Checklist

Schematic Checklist

1	Are B2B pin numbers on the connectors mirrored compared to the module pin numbers?	As B2B connectors are "unisex" type the do mirror pin numbers when connecting. That is pin1 connects to pin2, and pin2 to pin1, etc.
2	Are B2B connectors named JB1, JB2, JB3?	This is not a hard requirement, but it helps to use the same identifiers.
3	Are all GND pins connected to a common ground net?	
4	Are all VIN pins connected together?	
5	Is JB2 pin 92 pin used as VREF for the JTAG interface?	for future compatibility only, currently all modules have 3.3V JTAG
6	Are external circuits/buffers connecting to MIO bank 1 pins powered from JB1 pin 40?	JB1 pins 18, 20, 22, 24, 26, 28 use voltage at pin 40 as VCCIO. Currently it is 1.8V for all released modules.

PCB Checklist

1	Are mounting holes placed properly?	Four Mounting holes should always be used. They are required for mounting screws and for module extraction. The mounting holes will also help in dissipating some heat from the module to the carried board PCB. Four holes with a 3.2mm diameter should be placed exactly at the corners of a 37mm by 47mm rectangle.
2	Are B2B headers properly placed?	B2B headers must be placed and aligned very precisely or the module will not align correctly (in the worst case module insertion could destroy the connectors or the PCB). The B2B headers should be locked on the PCB, and it is recommended that the position and placement be checked against placement dimensions before submitting the PCB files.
3	Are B2B headers rotated properly?	As B2B header pin numbers differ from module to the carrier (swap of odd and even numbers), it is recommended that that the rotation is checked in the PCB design.
4	Height clearance below module	Components can be placed below the module but height clearance rules must be obeyed.
5	Power dissipation of components below module	It is not recommended to place any components with high power dissipation below the module, as there will be almost no airflow below the module.

Visual Check of Module placement

It is highly recommended to use the Base board Template designs as a starting point for new PCB designs. If that is not possible, then adding linear dimensions in the design helps to check that all connectors and mounting holes are properly placed.

A This placement is same for all 4x5 Modules!





Top view of the Carrier Board.

Connector numbers as on base! (pin JB1.1 on base would mate to pin JM1.2 on module).



Reference Projects

Binary files of the reference projects can be downloaded from the Trenz-Electronic download area.

Full Board Support Packages for Vivado CAN NOT BE CREATED AT THIS TIME. We have filed a WebCase (990721) and Xilinx has Answer Record AR58180 regarding this. The feature to create board support packages will hopefully be available with some later Vivado releases, but currently it is not known in which version. At least it is not confirmed for 2014.1 for sure.



Working with Reference Projects

A DEPRECATED - use Vivado/petalinux 2014.2 or newer

Boot Sequence

Reference projects follow the standard Zynq boot sequence:

Step	File	Name	Description
0		BootROM	Zynq boot ROM start up. No user access.
Base :	system project files		
1	system.bit	Bitstream	PL bitstream
2	FSBL.elf	FSBL	Standard Zynq First Stage Bootloader
U-Boo	t project files		
3	u-boot.elf	u-boot	U-Boot Second Stage Bootloader
Base system project files			
4	boot.bin, boot.mcs	boot file	Zynq boot image
Linux project files			
5	ulmage	Linux kernel	Linux kernel 3.9 wrapped to be used with U-Boot
	devicetree.dtb	Device Tree	Linux device tree blob (binary large object)
	uramdisk.image.gz	Ramdisk	Linux ramdisk image wrapped to be used with U-Boot

The Zynq boot ROM firmware

- reads boot mode settings,
- performs basic configuration,
- downloads and boots FSBL from the selected boot source.

The TE0720 module supports booting from the on-board QSPI Flash memory and from an external SD memory card.

Files from steps 1, 2 and 3 are used to create boot.bin or boot.elf images, which are used to initialize the QSPI Flash memory or an SD memory card.

Linux ramdisk image contain base linux system files with network services (ssh, http). Default IP: 192.168.42.50 SSH Password: "1234"





Projects Build

To build a high level project (like a Linux kernel), several steps should be performed:

- 1. Build a base PlanAhead project
- 2. Build an FSBL First Stage Boot Loader
- 3. Create an environment on Ubuntu or CentOS Linux to build U-Boot and Linux kernel
- 4. Build U-Boot
- 5. Build a Linux kernel, a device tree blob and a ramdisk



Base PlanAhead Project

A DEPRECATED - use Vivado 2014.2 or newer and start with Board Part Interface flow

Run Xilinx PlanAhead 14.5.



Click "Create New Project".



Create New Project

New Project Wizard will guide you through the process of selecting design sources and a target device for a new project.

Click "Next" to continue.

New Project	
	Create a New PlanAhead Project
	This wizard will guide you through the creation of a new project
	To create a PlanAhead project you will need to provide a name and a location for your project files. Next, you will specify the type of flow you'll be working with. Finally, you will specify your project sources and choose a default part.
	To continue, click Next.
	< Back Next > Einish Cancel

Select the project location and click "Next".



💽 New Project		
Project Name		
Enter a name	e for your project and specify a directory where the project data files will be stored	1
Project name:	TE0720-base	3
Project location:	B:/Temporary/TE0720	-
Create proje	ect subdirectory	
	< <u>B</u> ack <u>N</u> ext > <u>F</u> inish Cancel	

Click "Next".

New Project	×
Project Type Specify the type of project to create.	
 <u>R</u>TL Project You will be able to add sources, generate IP, run RTL analysis, synthesis, implement and analysis. <u>D</u>o not specify sources at this time 	itation, design planning
< <u>B</u> ack <u>N</u> ext >	inish Cancel

Select VHDL as a target language and click "Next".

New Project	- Nage Inc. prost	X
Add Sources		
Specify HDL and netlist files, or directorie Create a new source file on disk and add	es containing HDL and netlist files, to add to your project. I it to your project. You can also add and create sources	S
Add sources from subdirectories		
Target language: VHDL 🔻		
	< <u>B</u> ack <u>N</u> ext > Einish	Cancel

Click "Next".



New Project	×
Add Existing IP (optional)	
Specify existing configurable IP, DSP composite, and Embedded composite files to add to your project.	R
Add Files Add Directories	
✓ Copy sources into project	
1	
< Back Next > Finish	Cancel

Click "Next".

New Project	x
Add Constraints (optional) Specify or create UCF constraint files for physical and timing constraints.	Ø
<u>A</u> dd Files <u>C</u> reate File	
< <u>Back</u> <u>Next</u> > <u>Finish</u> Car	ncel

Select your chip using the following filter settings:

- Family: Zynq-7000
- Package: clg484



👸 New Proje	ect	-		the property of	2		i disan	×	
Default Pa Choose a	n rt a default Xilinx part	or board	for your projec	t. This can be ch	anged later.				
Specify	Filter								
🛞 Parts	Product category	All			 Package 	clg484		-	
🖉 Boards	<u>F</u> amily	Zynq-7	000		▼ Spee <u>d</u> grade	-2	-2 💌		
	S <u>u</u> b-Family	All Rem	aining		▼ <u>T</u> emp grade	C 🗸			
Search: Q	×			Reset	: All Filters				
Part	I/C Cou	Pin unt	Available IOBs	LUT Elements	FlipFlops	Block RAMs	DSPs	Gb Transceivers	
🔷 xc7z020d	lg484-2 484		200	53200	106400	140	220	0	
•								•	
					< <u>B</u> ack	Next >	Einish	Cancel	

Click "Finish" to create the project.

New Project	
	New Project Summary
	A new RTL project named 'TE0720-base' will be created.
	No source files or directories will be added. Use Add Sources to add them later.
	No Configurable IP files will be added. Use Add Sources to add them later.
	No constraints files will be added. Use Add Sources to add them later.
PlanAhead	The default part and product family for the new project: Default Part: xc7z020dg484-2 Product: Zynq-7000 Family: Zynq-7000 Package: dg484
	< <u>B</u> ack <u>N</u> ext > <u>Finish</u> Cancel

Click "Add Sources" in the "Project Manager" tab.





Select "Add or Create Embedded Sources" and then click "Next".

Add Sources	×
	Add Sources
	This guides you through the process of adding and creating sources for your project
	Add or <u>Create Constraints</u>
	Add or Create Design Sources
	Add or Create Simulation Sources
1	Add or Create DSP Sources
	Add or Create Embedded Sources
	Add Existing IP
PlanAhead	To continue, click Next
	< Back Next > Finish Cancel

Click "Create Sub-Design ... "



Add Sources	×
Add or Create Embedded Sources Specify embedded sub-design units by selecting XMP source files	ø
Id Name Location Id Name Location Add Sub-Design Create Sub-Design Image: Copy gources into project	*
< <u>B</u> ack <u>N</u> ext > <u>F</u> inish	Cancel

Enter a "Module name" for the Processing System and click "OK".

Create emb	bedded source	x
Create	a new embedded source and add it to your project	
Module name:	ps	Θ
	OK	ancel

Click "Finish".



Add	d Sou	urces	inter () feets	x
Add Sp	or C ecify	reate En embedde	nbedded Sources d sub-design units by selecting XMP source files	ġ
	Id	Name	Location	
6	1	ps.xmp	B:\Temporary\TE0720\TE0720-base\TE0720-base.srcs\sources_1	
			* *	
•				
			Add Sub-Design Create Sub-Design	
V	Сору	sources ir	nto project	
			< <u>B</u> ack Next > Einish Cancel	

Click "Yes" to add Processing System7 instance to the system.

Platfo	rm Studio
?	This project appears to be a blank Zynq project. Do you want to add Processing System7 instance to the system?
	Yes No

Download TE0720-01_a.xml from the Trenz Electronic Download Area.

Click "Import" in the Xilinx Platform Studio window.



Import

Click "+" to add a path to the downloaded xml file.



Select TE0720-01_a.xml from the list and click "OK".



	ssing Syste	em Configurati	ions					1			~
lect Configuration	Template										
/stem Template (Co	nfiguration	is available in th	e installed are	ea) :							
ZedBoard Development Board Template ZC702 Development Board Template ZC706 Development Board Template											
User Template (Configurations created by User) :											
E0720-01 a.xml											~
											¥
ummary of selected	Configurat	tion:									
Description Basic configuration for TE0720-01 module Preset Info Device Size xc7z020 Package dg484								<u> </u>			
Basic configur Preset Info Device Size Package Speed Grad	xc7z020 clg484 de -2	E0720-01 modul	e								II
Basic configur Preset Info Device Size Package Speed Grad	ation for Ti xc7z020 dg484 de -2 nfigur	E0720-01 modul	e								Ш
Basic configur Preset Info Device Size Package Speed Grac Zynq PS co Periphera	ation for Ti xc7z020 dg484 de -2 nfigur	e0720-01 modul	e MIO	Freg							н
Basic configur Preset Info Device Size Package Speed Grac Zynq PS co Periphera CAN0	ation for T clg484 de -2 nfigur status Enabled	E0720-01 modul ation Signal Group default	e MIO EMIO	Freq 100.000000							Е
Basic configur Preset Info Device Size Package Speed Grac Zynq PS co Periphera CAN0 CAN1	xc7z020 dg484 de -2 nfigur status Enabled Enabled	E0720-01 modul ation Signal Group default default	e MIO EMIO EMIO	Freq 100.000000 100.000000							ш
Basic configur Preset Info Device Size Package Speed Grac Zynq PS co Periphera CAN0 CAN1 ENETO	xc7z020 dg484 de -2 nfigur Enabled Enabled Enabled	E0720-01 modul Tation Signal Group default default default	e MIO EMIO EMIO MIO 16 27	Freq 100.000000 100.000000 1000 MBPS							ш
Basic configur Preset Info Device Size Package Speed Grac Zynq PS co Periphera CAN0 CAN1 ENET0	xc7z020 dg484 de -2 nfigur Enabled Enabled	E0720-01 modul ation Signal Group default default default GRP_MDIO	e MIO EMIO EMIO MIO 16 27 MIO 52 53	Freq 100,000000 100,000000 1000 MBPS							ш
Basic configur Preset Info Device Size Package Speed Grac Zynq PS co Periphera CAN0 CAN1 ENET0 ENET1	xc7z020 dg484 de -2 nfigur Enabled Enabled Enabled Disabled	ation Signal Group default default GRP_MDIO	MIO EMIO EMIO MIO 16 27 MIO 52 53	Freq 100.000000 100.000000 1000 MBPS							III

Click "Yes".



Select the "Ports" tab in "System Assembly View". Open *processing_system7_0->IIC_1* and configure I2C1_SDA_I, I2C1_SDA_O, I2C1_SDA_T, I2C1_SCL_I, I2C1_SCL_O and I2C1_SCL_T as "External Ports".



		<u> </u>
🖨 (IO_IF) IIC_1	Connected to External Ports	-
I2C1_SDA_I	External Ports::processing_system7_0_I2C1_SDA_I_pin	/ I
I2C1_SDA_O	External Ports::processing_system7_0_I2C1_SDA_0_pin	/ 0
I2C1_SDA_T	External Ports::processing_system7_0_I2C1_SDA_T_pin	/ 0
12C1_SCL_I	External Ports::processing_system7_0_I2C1_SCL_I_pin	<u>/</u> I
12C1_SCL_O	External Ports::processing_system7_0_I2C1_SCL_0_pin	/ 0
12C1_SCL_T	External Ports::processing_system7_0_I2C1_SCL_T_pin	/ 0
I2C1_SDA		/ IO
12C1_SCL		🥖 IO
	Max and a fixed to fixed as Date	

Select the "Ports" tab in "System Assembly View". Open *processing_system7_0->GPIO_0* and configure GPIO_I, GPIO_O and GPIO_T as "External Ports".

🖨 (IO_IF) GPIO_0	Connected to External Ports	-	
GPIO_I	External Ports::processing_system7_0_GPIO_I_pin	/ I	[31:0]
GPIO_O	External Ports::processing_system7_0_GPIO_0_pin	<u>/</u> 0	[31:0]
GPIO_T	External Ports::processing_system7_0_GPIO_T_pin	<u>/</u> 0	[31:0]
GPIO		🥖 IO	[31:0]
	Connected to Esternal Destr		

Run Hardware -> Generate Netlist from the main menu.

	Hardware		Debug	Window	Help			
ľ	Generate Netlist							
	Treate or Import Peripheral							
1	0	Configure Coprocessor						
t	•	🗊 Launch Clock Wizard						
8	Check and View Core Licenses							
1	1	Clean N	letlist					

Wait for the synthesis to complete and close "Xilinx Platform Studio".

Starting from this point, we are going to create a custom PS wrapper which communicates with the PS via the EMIO interface and pass I²C signals and one GPIO pin to the on-board CPLD chip.

Inside the CPLD, an I²C switch controlled by a GPIO pin is implemented.

Right-click on the created PS (ps.xmp) file and select "Create Top HDL".





Open the created "ps_stub.vhd" and make the following changes; alternatively, you can replace the created $ps_stub.vhd$ with that contained in the TE0720-01-Base.zip archive from the Trenz Electronic Download Area.

Comment external I2C1 and GPIO signals and add CPLD signals to the ps_stub entity.

-- processing_system7_0_l2C1_SDA_1_pin : in std_logic;
-- processing_system7_0_l2C1_SDA_0_pin : out std_logic;
-- processing_system7_0_l2C1_SDA_T_pin : out std_logic;
-- processing_system7_0_l2C1_SCL_1_pin : in std_logic;
-- processing_system7_0_l2C1_SCL_0_pin : out std_logic;
-- processing_system7_0_l2C1_SCL_T_pin : out std_logic;
-- processing_system7_0_GPI0_1_pin : in std_logic_vector(31 downto 0);
-- processing_system7_0_GPI0_T_pin : out std_logic_vector(31 downto 0);
-- l2C - CPLD connection
X5 : in STD_LOGIC; -- i2c_sda_out
X0 : out STD_LOGIC; -- i2c_ssw
X1 : out STD_LOGIC; -- i2c_scl_out



```
-- I2C TE0701
B33_L4_P : inout STD_LOGIC; -- TE0701 SCL
B33_L4_N : inout STD_LOGIC -- TE0701 SDA
);
end ps_stub;
```

Add signals to the architecture section.

attribute BOX_TYPE : STRING; attribute BOX_TYPE of ps : component is "user_black_box"; signal ps_i2c_sda_i : STD_LOGIC; signal ps_i2c_sda_o : STD_LOGIC; signal ps_i2c_sda_t : STD_LOGIC; signal ps_i2c_scl_i : STD_LOGIC; signal ps_i2c_scl_o : STD_LOGIC; signal ps_i2c_scl_t : STD_LOGIC; signal gpio_i : STD_LOGIC_VECTOR(31 downto 0); signal gpio_t : STD_LOGIC_VECTOR(31 downto 0); signal gpio_t : STD_LOGIC_VECTOR(31 downto 0); signal gpio_t : STD_LOGIC_VECTOR(31 downto 0);

Edit the PS mapping.

```
processing_system7_0_I2C1_SDA_I_pin => ps_i2c_sda_i,
processing_system7_0_I2C1_SDA_0_pin => ps_i2c_sda_o,
processing_system7_0_I2C1_SDA_T_pin => ps_i2c_sda_t,
processing_system7_0_I2C1_SCL_I_pin => ps_i2c_scl_i,
processing_system7_0_I2C1_SCL_0_pin => ps_i2c_scl_o,
processing_system7_0_I2C1_SCL_T_pin => ps_i2c_sda_t,
processing_system7_0_GPI0_I_pin => gpio_i,
processing_system7_0_GPI0_0_pin => gpio_o,
```



```
processing_system7_0_GPI0_T_pin => gpio_t
);
```

Add "glue" logic to the architecture section.

$$gpio_i <= x'' 12345678''; -- Stub for GPIO input signals$$

$$X0 <= not gpio_o(0); -- I2C bus switch control signal$$

$$ps_i2c_sda_i <= X5 and B33_L4_N; -- SDA in$$

$$ps_i2c_scl_i <= ps_i2c_scl_o or ps_i2c_scl_t; -- SCL feedback$$

$$X7 <= ps_i2c_sda_o or ps_i2c_sda_t; -- CPLD SDA$$

$$B33_L4_N <= ps_i2c_sda_o when (ps_i2c_sda_t = '0') else 'Z'; -- TE0701 SDA$$

$$X1 <= ps_i2c_scl_o or ps_i2c_scl_t; -- CPLD SCL$$

$$B33_L4_P <= ps_i2c_scl_o or ps_i2c_scl_t; -- TE0701 SCL$$

Save the file.

Click "Add Sources" in the "Project Manager" tab.



Select "Add or Create Constraints" and click "Next".



Add Sources	×		
	Add Sources		
	This guides you through the process of adding and creating sources for your project		
	Add or Create Constraints		
	Add or Create Design Sources		
	Add or Create Simulation Sources		
	Add or Create DSP Sources		
	Add or Create Embedded Sources		
	Add Existing IP		
PlanAhead	To continue, click Next		
< <u>B</u> ack	Next > Einish Cancel		

Click "Add Files..." and select *TE0720-01_base.ucf* contained in the TE0720-01-Base.zip archive from the Trenz Electronic Download Area.

Add Sources	x
Add or Create Constraints Specify or create constraint files for physical and timing constraint to add to your project.	ø
Specify constraint set: Constrs_1 (active)	×
<u>A</u> dd Files <u>Create File</u> ✓ Copy constraints files into project	
< <u>B</u> ack <u>N</u> ext > <u>Fi</u> nish Ca	ncel

Press "Generate Bitstream".

🚷 Generate Bitstream

Press "OK" to close the warning window.



C Launch Run Critical Messages	×
There were 3 critical warning messages launching implementation run.	
Messages	
[Constraints 18-5] Cannot loc instance 'processing_system7_0_PS_PORB_pin_IBUF' at site B5, Site location is not valid [B:/Temporary/TE0720/TE0720-base/TE0720-base. srcs/sources_1/edk/ps/implementation/ps_processing_system7_0_wrapp ncf: 154]	. III
[Constraints 18-5] Cannot loc instance 'processing_system7_0_PS_SRSTB_pin_IBUF' at site C9, Site location is not valid [B:/Temporary/TE0720/TE0720-base/TE0720-base. srcs/sources_1/edk/ps/implementation/ps_processing_system7_0_wrapp ncf: 155]	•
Constraints 18-5] Cannot loc instance	
OK Cancel Run Open Message	es View

Wait for the operation to complete.

Click "Open Implemented Design".

Open Implemented Design

Right click on the PS block and select "Export Hardware for SDK...".



Select "Include bitstream", "Export Hardware" and "Launch SDK" and press "OK".



C Export Hardware for SDK								
Export hardware platform for SDK.								
Options								
Source:	🗊 ps.xmp	-						
Export to:	🛜 <local project="" to=""></local>	-						
Workspace:	iso ≤Local to Project>	-						
 Include b	itstream (Note: an implemented design must be lo	aded)						
Export Ha	ardware							
Launch SDK								
	ОК	Cancel						

This step completes the base system build process. The next step describes how to build an FSBL.



Base XPS Project

DEPRECATED - use Vivado 2014.2 or newer and start with Board Part Interface flow

Clone the base project from the following Trenz Electronic GitHub repository.

git clone git://github.com/Trenz-Electronic/TE0720-GigaZee-Reference-Designs.git

Or just click on "Download ZIP" to download the full project archive without the need to use git.

Run Xilinx XPS 14.5.



Click "Open Project".



Select "system.xmp" from the project folder and clock "Open".

	🍪 Open Exist	ing Project	8 ×
1	Look in:	B:\GIT\TE0720-GigaZee-Reference-Designs\GigaZee_XPS14.5-Base 💽 🔇 🕥 🕥	📑 🎞 🖹
	Ny Co	omputer data etc implementation pcores ready_for_download	
	File <u>n</u> ame:	system.xmp	<u>O</u> pen
	Files of type:	Platform Studio Project (*.xmp)	Cancel

Click "Export Design" to build the project and export the result to Xilinx SDK.



Click "Export & Launch SDK".





Export to SDK / Launch SDK	? ×						
This dialog allows you to export hardware platform information to be used in SDK.							
✓ Include bitstream and BMM file							
(XPS will regenerate bitstream if necessary, and it may take some time to finish.)							
Directory location for hardware description files							
720-GigaZee-Reference-Designs\GigaZee_XPS14.5-Base\SDK\SDK_Export							
Export Only Export & Launch SDK Cancel	Help						

After build, the project will be opened in SDK. The next step is building the First Stage BootLoader.



FSBL - First Stage Boot Loader

A DEPRECATED - use Vivado 2014.2 or newer

Vivado 2013.4 FSBL

In 2013.4 much more error detection is added to the FSBL and the handling of those conditions has been changed by Xilinx. This makes it possible that incorrectly generated 2013.4 FSBL does lock-up and prevents any access to JTAG and SPI Flash (if SPI bootmode is selected).



__ 🗆 🗾 📈

Ι

Putty COM15 - Putty

```
BAS:IC>TE0701-03 boot...
Xilinx First Stage Boot Loader
Release 2013.4 Jan 14 2014-09:56:54
Devcfg driver initialized
Silicon Version 3.1
Boot mode is QSPI
Single Flash Information
FlashID=0xEF 0x40 0x19
WINBOND 256M Bits
QSPI is in single flash connection
QSPI Init Done
Flash Base Address: 0xFC000000
Reboot status register: 0x60400000
Multiboot Register: 0x0000C000
Image Start Address: 0x00000000
Partition Header Offset:0x00000C80
Partition Count: 2
Partition Number: 1
Header Dump
Image Word Len: 0x000F6EC0
Data Word Len: 0x000F6EBF
Partition Word Len:0x000F6EC0
Load Addr: 0x00000000
Exec Addr: 0x00000000
Partition Start: 0x000065D0
Partition Attr: 0x00000020
Partition Checksum Offset: 0x00000000
Section Count: 0x00000001
Checksum: 0xFFD14B7F
Bitstream
Encrypted
In FsblHookBeforeBitstreamDload function
PCAP:StatusReg = 0x40000A30
PCAP:device ready
PCAP:Clear done
Level Shifter Value = 0xA
Devcfg Status register = 0x40000A30
PCAP:Fabric is Initialized done
PCAP register dump:
PCAP CTRL 0xF8007000: 0x4E00E07F
PCAP LOCK 0xF8007004: 0x0000001A
PCAP CONFIG 0xF8007008: 0x00000508
PCAP ISR 0xF800700C: 0x0802000B
PCAP IMR 0xF8007010: 0xFFFFFFF
PCAP STATUS 0xF8007014: 0x0006DA30
PCAP DMA SRC ADDR 0xF8007018: 0x00100001
PCAP DMA DEST ADDR 0xF800701C: 0xFFFFFFF
PCAP DMA SRC LEN 0xF8007020: 0x000F6EC0
PCAP DMA DEST LEN 0xF8007024: 0x000F6EBF
PCAP ROM SHADOW CTRL 0xF8007028: 0xFFFFFFFF
PCAP MBOOT 0xF800702C: 0x0000C000
PCAP SW ID 0xF8007030: 0x00000000
PCAP UNLOCK 0xF8007034: 0x757BDF0D
PCAP MCTRL 0xF8007080: 0x30800100
DMA Done !
FPGA Done !
In FsblHookAfterBitstreamDload function
```

Ξ



Har	ndoff	Addre	288:	0x0(00000	000
In	Fsbl	lookBe	efore	eHand	doff	function
No	Exect	ution	Add	ress	JTA(5 handoff

This is FSBL bootlog on TE0701-03 with TE0720, no manual changes made to the FSBL. SPI flash programmed using Xilinx SDK Flash Programmer. Image includes only FSBL and empty BIT file for FPGA, so all it does is FPGA configuration (done LED goes OFF), and JTAG handoff, enabling all JTAG access.

Creating FSBL

The standard Zynq-7000 FSBL can be used to boot the TE0720 SoM. Unfortunately, SD Card Detect and Write Protect settings in the system configuration is not correctly processed by Xilinx XPS and the generated ps7_init.c file does not contain Card Detect and Write Protect pin configuration code. To make the SD memory card work, apply the patch below or connect the MIO0 pin to ground (default configuration for the Card Detect pin).

The creation of an FSBL requires a base PlanAhead project to be completed and a hardware structure to be exported to SDK (see last steps of the previous Base PlanAhead Project page).

Open the Xilinx SDK and close the "Welcome" tab.



Select File -> New -> Application Project.



😡 C	C/C++ - ps_hw_platform/system.xml - Xilinx SDK										
File	Edit	Source	Refactor	Navigate	Search	Run	Proj	ect	Xilinx Tools	Window	Help
	New				Alt+Shif	t+N ►	CÅ	Ma	kefile Project	with Existin	ng Code
	Open	File					C.	C+	+ Project		
	Close				Ctr	l+W	Ċ	СР	roject		
	Close All Ctrl+Shift+W			Application Project							
							۱ ۱	Boa	ard Support P	ackage	
	Save				Ct	rl+S	C	Pro	ject		
	Save A	E							-		

Specify the "Project name" as "FSBL" and the "Board Support Package" as "FSBL_bsp". Click "Next".

New Project					
Application Project					
Project name: FSBL					
Use default location					
Location: B:\Temporary\TE0720\TE0720-base\TE0720-base.sdk\SDK\SI Browse					
Chaose file system: default					
Target Hardware					
Target Software					
OS Platform	standalone				
Language					
Board Support Packag	e				
bound support ruckag					
A Section Cancel A					

Select the "Zynq FSBL" template and click "Finish".



🐵 New Project 📃 📼 💌						
Templates						
application project.						
Available Templates:						
Dhrystone Empty Application Hello World IwIP Echo Server Memory Tests Peripheral Tests Zyng FSBL	First Stage Bootloader (FSBL) for Zynq. The FSBL configures the FPGA with HW bit stream (if it exists) and loads the Operating System (OS) Image or Standalone (SA) Image or 2nd Stage Boot Loader image from the non-volatile memory (NAND/NOR/QSPI) to RAM (DDR) and starts executing it. It supports multiple partitions, and each partition can be a code image or a bit stream.					
(?) < <u>B</u> ack <u>N</u> e	xt > <u>F</u> inish Cancel					

Wait for the build to complete.

If your carrier board doesn't have SD "Card Detect" and "Write Protect" signals, then you have to disable them to make booting from the SD memory card possible.

Insert the following instructions after function "SlcrUnlock();" in "main.c".

This way, the SD "Card Detect" and "Write Protect" signals are connected to EMIO63, which should always be bound to logical 0 or left unconnected (floating).

TE0720 User Manual



👔 system.xml 👔 system.mss 🚺 main.c 🛛						
	<pre>#else /* * PCW initialization for MIO,PLL,CLK and DDR */ ps7_init(); #endif</pre>					
	<pre> /* * Unlock SLCR for SLCR register write */ SlcrUnlock(); </pre>					
	<pre>*((u32 *)0xF8000830) = 0x003F003F; // SD0 CD and WP to EMI063 *((u32 *)0xF8000834) = 0x003F003F; // SD1 CD and WP to EMI063</pre>					
	⊖ /* If Performance measurement is required					

Save the modified file "main.c": **File -> Save**; the project will be automatically rebuilt.

Select the "FSBL" project from the "Project Explorer" panel and run Xilinx Tools -> Create Zynq Boot Image.

C/C++ - FSBL_bsp/system.mss - Xilinx SDK						
File Edit Source Refactor Navigate Se	arch Run Project [Xilinx Tools Window Help				
	🕯 - 🚳 - 🖻 - G	S Generate linker script				
Project Evalorer 82	Board Support Package Settings					
	System.xm	Repositories				
□ → 🕰 FSBL	FSBL_bsp Boa	🚔 Program FPGA				
a 🏙 FSBL_bsp	Modify this BSP's	🛜 Program Flash				
i BSP Documentation ns7 cortexa9 0		Eaunch Hardware Server				
ibgen.log	Target Informatio	XMD Console				
📄 libgen.options	This Board Suppor	Launch Shell				
Makefile	Hardware Specific	Configure JTAG Settings				
system.mss	Target Proc	😝 System Generator Co-Debug Settings				
g ps7_init.c	Operating Suctom	📝 Create Zynq Boot Image				



- contained in the TE0720-01-U-Boot.zip archive from the Trenz Electronic Download Area,
- or built from the source code.

Click "Create Image".


		×		
Create Zynq Boot Image Creates Zynq Boot Image in .bin and .mcs formats from given FSBL elf and partition files in specified output folder.				
		-		
Export\FSBL\Debug\FSBL.elf		Browse		
Offset	Alignment	Add		
B:\Temporary\TE0720\TE0720-base\TE0720-base.sdk\SDK\SDK_Export\FSBL\Debug\FSBL.elf				
B:\Temporary\TE0720\TE0720-base\TE0720-base.sdk\SDK\SDK_Export\ps_hw_platform\system.bit				
B:\Temporary\u-boot\u-boot.elf				
		Down		
	, , , , , , , , , , , , , , , , , , ,			
Output folder B:\Temporary\TE0720\TE0720-base\TE0720-base.sdk\SDK\SDK_Export\FSBL\bootimage Browse				
_ C	create Image	Cancel		
	tion files in specified output folder Export\FSBL\Debug\FSBL.elf ebug\FSBL.elf platform\system.bit Export\FSBL\bootimage	tion files in specified output folder. Export\FSBL\Debug\FSBL.elf Offset Alignment ebug\FSBL.elf platform\system.bit Export\FSBL\bootimage Create Image		

The newly created .\TE0720-base.sdk\SDK\SDK_Export\FSBL\bootimage\u-boot.bin file should be renamed to boot.bin and placed onto the SD memory card.



Build Environment

It is possible to build Linux and u-boot only in a Linux environment; the easiest way to proceed is to install a suitable Linux distribution within a Virtual Machine.

Toolchain

The toolchain is available in the Xilinx download area, but it requires a Xilinx account (username and password). It may be that the user is temporarily not granted download permission. Some time later (could be a few hours to several days) an email from Xilinx will confirm that the user has download permission. The user can now download the installer binaries. When trying to install it on 64-bit Ubuntu, the installer says that it needs 32-bit libs, and provides an URL to a Mentor Graphics web page. This web page requires a Mentor Graphics account; after login, the page provides outdated information about installing ia32-libs.

Mentor Graphics Sourcery (formerly: CodeSourcery) toolchain has lots of troubles on 64-bit operating systems; some extra libraries need to be installed, both on CentOS and Ubuntu.

CentOS Linux kernel and the U-Boot build environment

To build U-Boot and the Linix kernel from their source files, you need to create and configure a build environment. VMware Player virtual machine with CentOS 6.4 Linux is used as a build environment.

Required software components:

- VMware Player V5.0.2
- CentOS V6.4 64-bit installer image
- Mentor Sourcery CodeBench GNU Toolchain for Xilinx Zynq-7000 (xilinx-2011.09-50-arm-xilinx-linux-gnueabi.bin, a Xilinx account is required)

Configure CentOS Guest Operating System

Open a "Terminal" window: **Applications -> System Tools -> Terminal**.



Switch to the root user.

SU

Install the packages required for the VMware Player tools and the kernel build.

yum install make gcc kernel-devel perl

From the VMware Player menu, run the installation of VMware tools: **Player -> Manage -> Install VMware Tools**.

In the Terminal window, mount the virtual CD-ROM image and install the VMware tools.

mkdir /mnt/cdrom



mount /dev/cdrom /mnt/cdrom

cd /tmp

tar zxpf /mnt/cdrom/VMwareTools*.tar.gz

umount /dev/cdrom

cd vmware-tools*

./vmware-install.pl

Add your main user account to the "sudoers" list.

cp /etc/sudoers /etc/sudoers.save echo "user ALL=(ALL) ALL" >> /etc/sudoers

where "user" should be replaced by your account name.

Reboot the virtual machine to apply changes: **System -> Shut Down**.

After reboot, open a "Terminal" window again: Applications -> System Tools -> Terminal.

Now complete the configuration.

sudo yum update sudo yum install ncurses-devel git glibc-devel.i686 gtk2-devel.i686 gtk-nodoka-engine.i686 | libcanberra.i686 libcanberra-gtk2.i686 PackageKit-gtk-module.i686 | GConf2.i686 ncurses-libs.i686 xulrunner.i686

Open the Firefox web browser.



Download the Mentor Sourcery CodeBench GNU Toolchain installer at http://www.xilinx.com/member/mentor_codebench/xilinx-2011.09-50-arm-xilinx-linux-gnueabi.bin (a Xilinx account is required).

Copy the xilinx-2011.09-50-arm-xilinx-linux-gnueabi.bin file to your home directory and run the installation.

cp Downloads/xilinx-2011.09-50-arm-xilinx-linux-gnueabi.bin ./

chmod ugo+x xilinx-2011.09-50-arm-xilinx-linux-gnueabi.bin

./xilinx-2011.09-50-arm-xilinx-linux-gnueabi.bin



Go through the installation steps choosing the "Typical" installation profile.

Add the path to CodeSourcery/Sourcery_CodeBench_Lite_for_Xilinx_GNU_Linux/bin/ folder to the PATH environment variable (preferably by adding it in the .bash_profile script).

Now, your virtual machine environment is ready to build U-Boot and the Linux kernel from their source files.



Ubuntu Linux kernel and U-Boot build environment

Required software components:

- VMware Player V5.0.2
- Ubuntu Desktop 12.04 LTS 32-bit installer image
- Mentor Sourcery CodeBench GNU Toolchain for Xilinx Zynq-7000 (xilinx-2011.09-50-arm-xilinx-linux-gnueabi.bin, a Xilinx account is required)

Install Ubuntu Desktop as VMware virtual machine.

After installation enable shared folder function. Shared folder can be used to pass files between guest and host systems.

Open "Virtual machine settings"

Edit virtual machine settings

Go "Options" tab and switch "Folder sharing" to "Always enabled" and press "Add...".



Settings	Summary	-Folder shar	ing	
General	Ubuntu	Share virtual	d folders expose your files l machine. This may put yo lata at risk. Only enable si	s to programs in the our computer and bared folders if you
Shared Folders	Disabled	trust t	the virtual machine with yo	our data.
WMware Tools	Time sync off	<u>D</u> is	abled	
Unity		Alv	vays <u>e</u> nabled	
la Autologin	Not supported	🔘 Ena	abled <u>u</u> ntil next power off	or suspend
		Eolders		
		Name	Host Path	
			Add Remo	ve <u>P</u> roperties

Click "Next".





Click "Browse" and select folder for sharing. Set name as "shared". Click "Next".

Add Shared Folder Wizard	×
Name the Shared Folder What would you like to call this shared folder?	
Host path	
B:\Temporary\shared	Browse
N <u>a</u> me	
shared	
< <u>B</u> ack <u>N</u> ext >	Cancel

Click "Finish".





Specify Shared Folder Attributes
specify the scope of this shared folder.
Additional attributes
Enable this share
Read-only
·
< <u>B</u> ack Finish Cancel

Click "OK" on "Virtual machine settings" window.

In virtual machine window.

Press "Ctrl+Alt+t" to run terminal.

In terminal window

sudo apt-get update

sudo apt-get install build-essential git ncurses-devel



On host system.

Download xilinx-2011.09-50-arm-xilinx-linux-gnueabi.bin from http://www.xilinx.com/member/mentor_codebench/xilinx-2011.09-50-arm-xilinx-linux-gnueabi.bin (You will need Xilinx account to download). Put downloaded file to shared folder.

In virtual machine terminal window.

cp /mnt/hgfs/shared/xilinx-2011.09-50-arm-xilinx-linux-gnueabi.bin ./ sudo dpkg-reconfigure -plow dash



Select "<No>"

😣 🖨 💷 user@ubuntu: ~
Package configuration
Configuring dash
The system shell is the default command interpreter for shell scripts.
Using dash as the system shell will improve the system's overall performance. It does not alter the shell presented to interactive users.
Use dash as the default system shell (/bin/sh)?
<yes> <no></no></yes>

Run "Sourcery CodeBench GNU Toolchain" installation

./xilinx-2011.09-50-arm-xilinx-linux-gnueabi.bin

Go through the installation steps choosing the "Typical" installation profile.

Now, your virtual machine environment is ready to build U-Boot and the Linux kernel from their source files.



U-Boot

A DEPRECATED - use petalinux 2014.2 or newer and TE0720 BSP

Get the U-Boot Repository

Start the build environment (CentOS within the VMware Player virtual machine) prepared in the previous CentOS Linux kernel and the U-Boot build environment page.

Open a Terminal window: Applications -> System Tools -> Terminal.



In the terminal window, enter the following command to download the U-Boot source files from the Trenz Electronic Git repository.

git clone git://github.com/Trenz-Electronic/u-boot-xlnx.git u-boot-te

Build U-Boot

In the terminal window, enter the following commands to build U-Boot.

cd u-boot-te export CROSS_COMPILE=arm-xilinx-linux-gnueabi-

The configuration command has to be chosen according to the relevant module version.

Model	Command
TE0720-01-2IF	make TE0720-01-2IF_config



Model	Command
TE0720-01-2EF	make TE0720-01-2EF_config
TE0720-01-1CF	make TE0720-01-1CF_config
TE0720-01-1CR	make TE0720-01-1CR_config

Build U-boot binary



Now, you should have the U-Boot file in the working "u-boot-te" folder. To copy this file to the Microsoft Windows host system, open a file browser: **Applications -> System Tools -> File Browser**.



Locate the "u-boot" file and copy it to the guest system clipboard by pressing "Ctrl+C".

Switch to the Microsoft Windows host system, open a Windows Explorer window, browse to the base PlanAhead project folder and paste the "u-boot" file from the host system clipboard by pressing "Ctrl+V". Rename "u-boot" to "u-boot.elf".

Now, the "u-boot.elf" file can be used to build the Zynq-7000 boot image (last step of the FSBL build process).

U-Boot user scripting

The default TE0720 u-boot configuration supports user script execution when booting from an SD memory card. The U-Boot script image file **u-boot.cmd**, if it exists, will be executed before the normal boot.

To extend or replace the default SD-boot sequence:



 Create a script file with u-boot commands. Example: File name: u-boot.cmd.src
 File content:

echo ====== U-Boot user script ========

• Pack the script into the u-boot script format:

mkimage -T script -C none -n 'User script' -d u-boot.cmd.src u-boot.cmd

• Copy the u-boot.cmd file to the SD memory card.



Linux kernel 3.9

A DEPRECATED - use petalinux 2014.2 or newer with TE0720 BSP

Get Trenz Electronic Linux Kernel Repository

Start the build environment (CentOS within the VMware Player virtual machine) prepared in the previous CentOS Linux kernel and the U-Boot build environment page.

Open a Terminal window: **Applications -> System Tools -> Terminal**.



In the terminal window, enter the following command to download the Linux Kernel source files from the Trenz Electronic Git repository.

git clone git://github.com/Trenz-Electronic/linux-te-3.9

Build the Linux Kernel

To build a U-Boot wrapped image, the PATH environment variable should contain the path to the mkimage executable. It can be done by adding the path to the ~/u-boot-te/tools/ folder (its path depends on your U-Boot repository location) to the PATH environment variable, or installing the uboot-tools package.

In the terminal window, enter the following commands to build the Linux kernel.

cd linux-te export CROSS_COMPILE=arm-xilinx-linux-gnueabimake ARCH=arm te_zyng_defconfig



make ARCH=arm LOADADDR=0x8000 ulmage

Compile the device tree binary using one of the following commands according to the relevant module version.

Model	Command
TE0720-01-2IF	make ARCH=arm TE0720-01-2IF.dtb
TE0720-01-2EF	make ARCH=arm TE0720-01-2EF.dtb
TE0720-01-1CF	make ARCH=arm TE0720-01-1CF.dtb
TE0720-01-1CR	make ARCH=arm TE0720-01-1CR.dtb

The resulting device tree blob (TE0720-01-2IF.dtb, TE0720-01-2EF.dtb, TE0720-01-1CF.dtb or TE0720-01-1CR.dtb) will be created into the ./arch/arm/boot/dts folder.

Rename the resulting device tree blob as devicetree.dtb by using one of the following commands according to the relevant module version.

Model	Command
TE0720-01-2IF	mv ./arch/arm/boot/dts/TE0720-01-2IF.dtb ./arch/arm/boot/dts/devicetree.dtb
TE0720-01-2EF	mv ./arch/arm/boot/dts/TE0720-01-2EF.dtb ./arch/arm/boot/dts/devicetree.dtb
TE0720-01-1CF	mv ./arch/arm/boot/dts/TE0720-01-1CF.dtb ./arch/arm/boot/dts/devicetree.dtb
TE0720-01-1CR	mv ./arch/arm/boot/dts/TE0720-01-1CR.dtb ./arch/arm/boot/dts/devicetree.dtb

Now, you should have the Linux kernel image (wrapped for u-boot) **./arch/arm/boot/ulmage** and the device tree blob **./arch/arm/boot/dts/devicetree.dtb**. To copy these files to the Microsoft Windows host system, open a file browser: **Applications -> System Tools -> File Browser**.





Locate the files and copy them to the guest system clipboard by pressiing "Ctrl+C".

Switch to the Microsoft Windows host system, open a Windows Explorer window, browse to a suitable folder and paste the files from the host system clipboard by pressing "Ctrl+V".





Preparing boot media

TE0720 module supports 2 boot modes:

- SD memory card boot
- QSPI Flash memory boot

SD memory card boot

The SD memory card Zynq should boot from shall contain a FAT partition with the following files:

File	Build	Description
boot.bin	FSBL - First Stage Boot Loader	Zynq boot image file. Contains fsbl.elf, system.bit and u-boot.elf.
devicetree.dtb	Linux	Linux device tree blob file
ulmage	Linux	Linux kernel image (with u-boot wrapper)
uramdisk.image.gz	Build and Modify a Rootfs	Linux ramdisk (with u-boot wrapper)

Care should be taken not to corrupt the file system, please use "halt" or "umount /mnt/sd0" before power off board.

QSPI Flash memory boot

Unfortunately, the Winbond W25Q256 QSPI Flash memory assembled on the TE0720 is not yet suported by Xilinx iMPACT software tool. The easiest way to initialize the on-board QSPI Flash memory is to copy the data from the SD memory card using u-boot.

- Prepare the SD memory card as specified in SD memory card boot
- Connect the UART to the MIO pins (MIO14/MIO15 used in default FSBL), set the baudrate to 115200, no parity
- Set the boot mode to SD memory card
- Insert the SD memory card and power on the module
- Stop u-boot boot sequence by pressing the enter key during boot countdown
- Load data from the SD memory card to the DDR3 memory using the "run sdfetch" u-boot command
- Write data to the QSPI Flash memory from the DDR3 memory using "run reflash_all" u-boot command

After that, the QSPI Flash memory boot mode can be enabled and used.

QSPI Flash memory map

Address	Size	File	Description
0x000000	0x450000	boot.bin	Zynq boot image



Address	Size	File	Description
0x450000	0x500000	ulmage	Linux kernel image
0x950000	0x020000	devicetree.dtb	Linux device tree blob
0x970000	0x5E0000	uramdisk.image.gz	Linux ramdisk image

To change these addresses, the u-boot default configuration shall be changed and u-boot shall be rebuilt.



Base Vivado Project

Clone the base project from the following Trenz Electronic Github repository https://github.com/Trenz-Electronic/TE0720-GigaZee-Reference-Designs/tree/master/TE0720-01_Base_Viva

or download it from "Download area"

http://www.trenz-electronic.de/fileadmin/docs/Trenz_Electronic/TE0720-GigaZee/reference_designs/TE0720-

Run Vivado 2013.4



In "Tcl Console"

cd c:/temp/TE0720-01_Base_Vivado-2013.4/

where "c:/temp" should be replaced to real path to project directory.

In "Tcl Console"

source create.tcl

This command create new project in "base" directory and import used files.

Click Run Synthesis and wait synthesis to complete.

Click Generate Bitstream and wait operation to be completed.

Double click on "zynq_sys_i" to open block design.



"zynq_sys" should looks like







MIO configuration is



Peripheral		IO
	y Interfaces	
± V	Quad SPI Flash	MIO 16 🔹
. .	SRAM/NOR Flash	
±	NAND Flash	
🕂 I/O Per	ripherals	
± 🚺	ENET 0	MIO 1627 🔹
⊕ 🔲	ENET 1	
± 🔽	USB 0	MIO 28 39 🔹
🔳	USB 1	
± V	SD 0	MIO 40 45 🔹
± 🚺	SD 1	MIO 4651 🔹
± 🔽	UART 0	MIO 14 15 🔹
₽ 🔲	UART 1	
± 🔽	I2C 0	EMIO 👻
± 🚺	I2C 1	EMIO 👻
± 🕅	SPI 0	
₽ . ■	SPI 1	
± 🕅	CAN 0	
⊕ 🔲	CAN 1	
🖻 GPI	0	
.	GPIO MIO	MIO 🔻
	MIO GPIO (Width)	32 🔻
+	Resets	
- Applica	ition Processor Unit	
🔽	Timer 0	EMIO
	Timer 1	
····· 🔳	Watchdog	
⊕ Progra	mmable Logic Test and Debug	
Click	📸 Open Implemented Design	

Select "File - Export - Export Hardware for SDK..."



File	Edit	Flow	Tools	Window	Layout	View	Help
2	New P	roject					
3	Open l	Project.					
	Open I	Recent	Project		- F		
	Open I	Example	e Project	t	•		
	Save P	roject A	\s				
	Write F	Project '	Tcl				
	Archiv	e Proje	ct				
	Close I	Project					
	Save B	lock De	sign	St	rg+S		
	Close I	Block D	esign				
	Open (Checkp	oint				
	Open l	Recent	Checkpo	pint	•		
	Write (Checkp	oint				
	New IP	Locati	on				
	Open I	P Locat	tion				
	Open I	Recent I	IP Locati	ion	- F		
	New Fi	ile					
	Open l	File		St	rg+O		
	Open I	Recent	File		•		
	Save A	II Files					
8	Add So	ources		Al	t+A		
	Open S	Source	File	St	rg+N		
	Export				•	Expo	ort Hardware for SDK
	export					Expo	ort Hardware for SDK

Select all checkboxes and press "OK"

🚴 Export Hardware for SDK 🙀 🙀 👘 👘							
Export hardware platform for SDK.							
Options							
Source:	📥 zynq_sys.bd	-					
Export to:	🛜 <local project="" to=""></local>	-					
Workspace: 🔂 <local project="" to=""> 👻</local>							
Export Ha	ardware						
✓ Include bitstream (Note: an implemented design must be loaded) ✓ Launch SDK							
	OK	Cancel					

In "Xilinx SDK" window



Select "File - Import..."

File	Edit Source Refactor	Navigate Search Run
	New Open File	Alt+Shift+N ►
	Close Close All	Ctrl+W Ctrl+Shift+W
	Save	Ctrl+S
e. G	Save All Revert	Ctrl+Shift+S
	Move	
63	Rename Refresh	F2 F5
	Convert Line Delimiters To	•
Ð	Print	Ctrl+P
	Switch Workspace Restart	*
2	Import	

Select "General - Existing Projects into Workspace" and press "Next >"



🐵 Import	
Select Create new projects from an archive file or directory.	Ľ
Select an import source:	
type filter text	
 ▲ General Archive File ☆ Existing Projects into Workspace File System Preferences ▷ C/C++ ▷ Install ▷ Remote Systems ▷ ☆ Run/Debug ▷ Team 	
(?) < <u>Back</u> <u>Next ></u> <u>Finish</u>	Cancel

Check "Select root directory:" and press "Browse". Navigate to "sw_export" directory in project.

Check "Copy projects into workspace". Press "Finish"



🚳 Import		
Import Projects Select a directory to searc	ch for existing Eclipse projects.	
 Select root directory: Select archive file: 	C:\temp\TE0720-01_Base_Vivado-2013.4\sw_export	B <u>r</u> owse
FSBL (C:\temp\Tf	E0720-01_Base_Vivado-2013.4\sw_export\FSBL) np\TE0720-01_Base_Vivado-2013.4\sw_export\FSBL_bsp	<u>S</u> elect All <u>D</u> eselect All R <u>e</u> fresh
Copy projects into wo	III •	
Working sets	ing sets	S <u>e</u> lect
?	< <u>B</u> ack <u>N</u> ext > <u>F</u> inish	Cancel

Project will build automatically. After complete build, run "Xilinx Tools - Create Zynq Boot Image".



Xilin	x Tools Window Help
5	Generate linker script
UN.	Board Support Package Settings
0	Repositories
*	Program FPGA
7	Dump/Restore Data File
7	Program Flash
X	XMD Console
>	Launch Shell
	Configure JTAG Settings
8	System Generator Co-Debug Settings
	Create Zynq Boot Image

Select path for output.bif and Add FSBL, bit and u-boot files to Image.



😡 Create Zynq	Boot Image	x
Create Zynq I Creates Zynq folder.	Boot Image Boot Image in .bin and .mcs formats from given FSBL elf and partition files in specified output	
Oreate new E	IF file 💿 Import from existing BIF file	
BIF file path	C:\temp\TE0720-01_Base_Vivado-2013.4\output.bif	Browse
🔲 Use Authent	cation	
Authenticatio	n keys	
РРК	Browse PSK	Browse
SPK	Browse SSK	Browse
SPK Signature	Browse	
Use encrypti		
Encryption key	/	
Key file		Browse
Key store	BRAM	
Part name		
Boot image par	itions	
File path		Add
(bootloader) (:\temp\TE0720-01_Base_Vivado-2013.4\base\base.sdk\SDK\SDK_Export\FSBL\Debug\FSBL.elf	Delete
C:\temp\TE07	20-01_Base_Vivado-2013.4\base\base.runs\impl_1\top.bit 20-01_Base_Vivado-2013.4\u-boot.elf	Edit
C. (cc.).p (1201)		
		U DP
•	4	Down
Output path	C:\temp\TE0720-01_Base_Vivado-2013.4\boot.bin	Browse
?	Create Image Ca	ancel

Click "Create Image".

Copy "boot.bin", "devicetree.dtb", "ulmage" and "uramdisk.image.gz" files from project directory to SD card.



Vivado Flow (Video and Step-by-Step Tutorial)

- Creating a Vivado Example Project for TE0720 Zynq SoC Module
 - Video Tutorial (Vivado 2013.2)
 - Step-by-Step Tutorial (Vivado 2013.3)
 - Getting Started: Create New Vivado Project
 - Creating Vivado Block Design (IP Integrator)
 - Software Implementation: Create First Stage Boot Loader (FSBL) and "Hello World" application project in SDK
 - Hardware Synthesis & Implementation
 - Software Implementation: "Hello World 2.0" (implementing access to I2C peripherals via Xilinx Zynq PL custom logic)
- Debugging the "Hello World" Project
 - Video Tutorial
 - Step-by-Step Tutorial

Press "<Strg> + <Pos1>" to return back to this overview!

Creating a Vivado Example Project for TE0720 Zynq SoC Module

Video Tutorial (Vivado 2013.2)

The following screen-recording video shows how to create a new project in Vivado, how to set up a Zynq system, how to configure it properly, and how to export it to SDK. In SDK a standard *First Stage Boot Loader* (FSBL) is created and a "Hello world" project is generated as well as compiled. As a final step both software parts (FSBL and "Hello world") are combined in a boot image that is ready to be flashed or copied to an SD card:

The FSBL from this project could also be started in a debugger but it would not make any terminal output. Just proceed to load from SPI flash or SD Card depending on the boot mode when started in a debugger. The "Hello world" project can be run from the debugger but ps7_init (see TE0720 GigaZee Zynq SoM / TE0720 User Manual / FSBL - First Stage Boot Loader) TCL script must be executed first.

To start the "Hello World" project from an SD Card just copy the file "BOOT.BIN" to the SD card.

Note: This project does not include any FPGA bitstream, so the FPGA will not be configured and LED3 on the TE0720 module will remain lit!

Step-by-Step Tutorial (Vivado 2013.3)

1

Full Board Support Packages for Vivado CAN NOT BE CREATED AT THIS TIME. We have filed a WebCase (990721) and Xilinx has Answer Record AR58180 regarding this. The feature to create board support packages will hopefully be available with some later Vivado releases, but currently it is not known in which version. At least it is not confirmed for 2014.1 for sure.

Currently, we are working on a patch so that a custom board support package can be made available manually by just copying our TE0720 BSP files into the corresponding Vivado subdirectory (e.g., C: \Xilinx\Vivado\2013.3\data\boards\zynq). Meanwhile, corresponding to the Answer Record AR58180 you have to choose as part the on-board Xilinx Zynq FPGA device (e.g., xc7z020clg484-2) and specify the remaining settings (e.g., pin locking, IO voltages etc.) in a user defined contraint file as described in the following tutorial.

In the following, our video tutorial above is shown in a step-by-step manner (to whom it may prefer):

Getting Started: Create New Vivado Project

1.) Create a new project in Vivado 2013.3:



2.) Choose an appropriate project name, e.g., "TE0720_HelloWorld", and project directory location:



🚴 New Project	t
Project Name Enter a name	ie for your project and specify a directory where the project data files will be stored
Project name:	TE0720_HelloWorld
Project location:	: D:/Trenz-Electronic
Create proje	ect subdirectory
Project will be cr	reated at: D:/Trenz-Electronic/TE0720_HelloWorld
	< <u>B</u> ack <u>N</u> ext > <u>Finish</u> Cancel

3.) The type of project should be RTL Project with the option "Do not specify soruces at this time" disabled:

🚴 New Project	X
Project Type Specify the type of project to create.	$\mathbf{\lambda}$
 <u>B</u>TL Project You will be able to add sources, generate IP, run RTL analysis, synthesis, implementation, design planning an analysis. <u>D</u>o not specify sources at this time <u>Post-synthesis Project</u> You will be able to add sources, view device resources, run design analysis, planning and implementation. <u>D</u>o not specify sources at this time 	d
 J/O Planning Project Do not specify design sources. You will be able to view part/package resources. Imported Project Create a Vivado project from a Synplify, XST or ISE Project File. 	
< <u>B</u> ack <u>Next</u> > <u>Finish</u> C	ancel

4.) The target language is selected to be VHDL:



TE0720 User Manual

1	New Pro	oject							X
Ad	d Source	25							
	Specify I	HDL and r	netlist files,	or directories containing	g HDL and netlist	files, to a	dd to your pr	oject. Create a new	
	source r	lie on disi	k and add n	to your project. You ca	n also add and c	reate sour	ces later.		
	Index	Name	Library	HDL Source For	Location				
									X
									L.
			4	Add Files Ad	d Directories	<u>C</u> re	eate File		
	Scan an	d add RT	L <u>i</u> nclude fi	les into project					
\checkmark	Copy <u>s</u> o	urces into	o project						
\checkmark	Add so <u>u</u>	rces from	n subdirecto	ories					
l .									
	arget lar	iguage:	VHDL ▼ 1	Simulator language:	Mixed *				
-			1.						
						< <u>B</u> ack	<u>N</u> ext >	2. Einish Ca	ancel

5.) ... and in the dialog no existing IP is added...

1	New Pro	oject			X
	Add Existin	ng IP (op	tional)	DSP compacite and Embedded compacite files to add to your project	
	Specify	existing o	onngurable 1F,	bsr composite, and embedded composite mes to add to your project.	
	Index	Name	Location		
					\mathbf{x}
				Add Files Add Bire Assist	
	Conv so	urces into	project	Aga Files Aga Directories	
	Cobl 20		, hi olece		
				< <u>B</u> ack <u>Next</u> > <u>F</u> inish	Cancel

6.) ... as well as no constraints are specified:





🚴 New Project		X
Add Constraints Specify or cre	s (optional) eate constraint files for physical and timing constraints.	2
Constraint File	Location	*
Copy constra	Add Files Create File	
	< Back Next > Finish Car	ncel

7.) As long as the Vivado patch has not been released yet (see our notice above), please select the on-board TE0720 Zynq FPGA device (e.g., xc7z020clg484-2):

🚴 New Pro	oject									X
Default Part										
Choose a default Xilinx part or board for your project. This can be changed later.										
Specify Filter										
Parts	Product category All			All 👻			<u>P</u> ackage	clg484		-
Boards	<u>F</u> amily Zyng		Zynq-7	ynq-7000 🔻		Spe	ee <u>d</u> grade	All Remaining		-
	S <u>u</u> b-Far	mily	Zynq-7	000	- <u>T</u>		mp grade	All Remaining		-
					Reset All Filters					
Search: Q	Search: Q-									
Part		I/O Pin Count		Available IOBs	LUT Elemen	LUT Elements		Block RAMs	DSPs	
🔷 xc7z0200	lg484-3 4	484		200	53200		106400	140	220	
xc7z0200	lg484-2 4	484		200	53200		106400	140	220	
				200	53200		106400	140	220	
•										
					< <u>B</u> ack		<u>N</u> ext >	<u>F</u> inish	Ca	ncel

As soon as our custom board "TE0720-01-2EF" will be supported by Xilinx Vivado, it can be chosen in the following way:



Specify Filter								
Reards Family Zvng-7			000	•	Spee <u>d</u> grade	e All Remaining		
bourds	S <u>u</u> b-Fami	ly Zynq-7	000	.	<u>T</u> emp grade	All Remaining	-	
				Reset All F	ilters			
Search: Q-								
Part	I/C	D Pin bunt	Available IOBs	LUT Elements	5 FlipFlops	Block RAMs	DSPs	
🔷 xc7z020cl	g484-3 48	4	200	53200	106400	140	220	
xc7z020cl	g484-2 48	4	200	53200	106400	140	220	
₩ XC72020Clj	y484-1 48	4	200	53200	100400	140	220	

8.) Finally, create the previously parametrized RTL project:

👃 New Project							
	New Project Summary						
	(A new RTL project named 'TE0720_HelloWorld' will be created.						
	▲ No source files or directories will be added. Use Add Sources to add them later.						
	⚠️ No Configurable IP files will be added. Use Add Sources to add them later.						
	⚠️ No constraints files will be added. Use Add Sources to add them later.						
	 The default part and product family for the new project: Default Board: TE0720-01-2EF Default Part: xc7z020clg484-2 Product: Zynq-7000 Family: Zynq-7000 Package: clg484 Speed Grade: -2 						
2013.3	To create the project, click Finish						
	< <u>Back</u> <u>Next</u> > <u>Finish</u> Cancel						



Creating Vivado Block Design (IP Integrator)

1.) Create a new block design and name it. Here, we choose the default name "design_1":

🗠 TE0720_HelloWorld - [D:/Trenz-Electronic/TE0720_HelloWorld/TE0720_HelloWorld/FD720_HelloWo								
File Edit Flow Tools Window Layout View Help								
🟄 🔄 ini 💷 🦍 🖄 🈓 🏂 🌀 🎇 Default Leyout 🔷 🕷 🐁 😨								
Flow Navigator «	Project Manager - TE0720_HelloWorld	×						
🔍 🖾 🖨	Sources _ D & ×	∑ Project Summary ×						
A Project Manager	🔍 🖾 岸 📾 谢 📓 🛃	Project Settings Edit *						
Index Insulation Control Settings Add Sources Project Settings Add Sources Protect Settings Add Sources Protect Settings Create Block Design Simulation Simu	Image: Sources Image	 Project name: IE5720_1525 (x22020_0585.2) Tep module name: Iso 1267.00 1267 (x22020_0585.2) Tep module name: Iso 1267.00 1267.01						
	Design Runs							
	Name Part Constraints	Strategy Status Progress Start Elapsed Failed Routes WNS TNS WHS THS TPWS Description Virado Sumboric Dafaulte (Virado Sumboric 2013) Not et started 000						
		Vivodo Syndread Vetruita (Vivodo Implementation 2013) Not Started 0% Vivodo Implementation Debutts (Vivodo Implementation 2013) Not Started 0%						
	₩ <	III						
	📑 Tcl Console 🔎 Messages 🔤 Log 🕒 Reports 👒 Design	Runs						
Create and add an P subsystem to the protect								

2.) Continue to add new IP (1) from the catalog and select ZYNQ7 Processing System (2):





3.) In the same "Diagram" window a "ZYNQ7 Processing System" block symbol is now visible. After a double click on it, the following "Re-customize IP" dialog will appear, where you click on "Import XPS Settings" and choose the file "TE0720-01_a.xml", which can be found in the archive TE0720-01-Common.zip on the Trenz-Electronic Homepage (see *reference designs* in the download area of the TE0720-GigaZee):





4.) After successful import, the dedicated I/O pin assignments of the enabled peripherals can be checked...



5.) ... (optional) when you would like check by an application on the Zynq FPGA if a SD card is inserted (CD=0) or if its write protection (WP=1) is enabled, then you must assign the corresponding two signals to


MIO pins. Because almost all MIO pins have been already assigned (and MIO7 to MIO9 are not routed to the TE0701's CPLD), a possible solution is to deactivate the second UART1 (just by clicking on green colored "UART1" box, which can be found in the "Peripheral I/O Pins" page; see above) and re-assigned the now available MIO12 and MIO13 pins on the "MIO Configuration" page to the CD and WP pins of the SD 0 port:

🖵 Re-customize IP	- 8	diffic beingen in a		-	damps, i. present	-	×
ZYNQ7 Processing S	ystem (5.3)						2
🍘 Documentation 🊳 Pres	ets 늡 IP Location 🊳 Imp	ort XPS Settings					
Page Navigator «	MIO Configuration Summary Report						
Zynq Block Design	+ Bank 0 IO Voltage	VCMOS 3.3V 🔻	Bank 1 IO Volta	ge LVCMOS 1.8V	•		
PS-PL Configuration	Search: Q-						
Peripheral I/O Pins	😂 Peripheral	ю	Signal	ІО Туре	Speed	Pullup	Direction
MIO Configuration	📲 🗄 Memory Interfac	es					
	I/O Peripherals						
Clock Configuration	ENET 0	MIO 16 27	•				
DDR Configuration							
SMC Timing Calculation	🕀 🔽 USB 0	MIO 2839	•				
Tetermute	- 🔲 USB 1						
Interrupts	📄 🔽 SD 0	MIO 40 45	•				
	😑 🔽 CD	MIO 12					
		MIO 12	cd	LVCMOS 3.3V	✓ slow	✓ disabled ✓	in
	E 🔽 WP	MIO 13	•	h			1
		MIO 13	wp	LVCMOS 3.3V	✓ slow	✓ disabled ▼	in
	- Dower			L.		-	·
	- SD 0	MIO 40	clk	LVCMOS 1.8V	✓ fast	✓ disabled ▼	inout
	- SD 0	MIO 41	cmd	LVCMOS 1.8V	▼ fast	▼ disabled ▼	inout
	- SD 0	MIO 42	data[0]	LVCMOS 1.8V	▼ fast	✓ disabled ▼	inout
	- SD 0	MIO 43	data[1]	LVCMOS 1.8V	▼ fast	▼ disabled ▼	inout
	SD 0	MIO 44	data[2]	LVCMOS 1.8V	▼ fast	disabled ▼	inout
		MIO 45	data[3]	LVCMOS 1.8V	▼ fast	✓ disabled ▼	inout
	🕀 🔽 SD 1	MIO 46 51	•				
	🕀 🔽 UART 0	MIO 14 15	•				
	UART 1						
	🕀 🔽 I2C 0	MIO 10 11	•				
	⊞ 🔽 I2C 1	EMIO	-				
	+ 🔽 SPI 0	EMIO	-				
		EMIO	-				
		EMIO					
	CAN 1	EMIO	•				
	GPI0 GPI0 GPI0 GPI0 GPI0 GPI0	ssor Unit					
	Programmable L	ogic Test and Debug					
						ОК	Cancel

The MIO pins may be preferred towards the EMIO interface because for the latter a *programmable logic* (PL) bitfile must always be provided. Moreover, the EMIO interface is not available for the *First Stage Boot Loader* (FSBL) because at this stage, the PL has not been configured yet. Of course, in this case the TE0701 CPLD must internally connect the SD_DETECT and SD_WP signals to the corresponding signals, e.g., MIO12 and MIO13, respectively. Alternatively, the values



of SD_DETECT and SD_WP can also be read by the Xilinx Zynq after booting up via the on-board I2C bus (see Carrier Boards for TE0720 | Reading I2C-to-GPIO Status Register on TE0701 CPLD for more details).

However, the latest solution will not work for the device manager in Linux. Hence, be aware when tying up the corresponding EMIO pins statically to ground that the SD card WILL NOT be write-protected in dependence of the mechanical switch on the SD card anymore as the user might expect!

6.) ... also the DDR Configuration should have the following new timing settings (instead of 0.0 ns each):



7.) Back in the "Diagram" window right click on the IO port of the DDR interface and select in the context menu "Make External"...





8.) ... repeat step 6 for the ports FIXED_IO (1), GPIO_0 (2), and IIC_1 (3). Then, manually connect the ports "FCLK_CLK0" and "M_AXI_GP0_ACLK" to each other (4) and regenerate layout (5):





The signal path from "FCLK_CLK0" to "M_AXI_GP0_ACLK" is set because the PS provides four fully programmable clocks (FCLK_CLK/r, as shown in the following figure) to the PL and it is a common practice to exploit one of these clocks (namely, "FCLK_CLK0") to source the AXI bus clock (in this case with 100 MHz):

🕖 Documentation 🏀 Pr	mentation 🍓 Presets 🗁 IP Location 🍓 Import XPS Settings						
Page Navigator «	Clock	k Configuration				Summary Report	
Zynq Block Design	+ 1	Input Frequency (MHz) 33.33	3333 💿 CF	U Clock Ratio 6:2:1	•		
PS-PL Configuration	♀ <u>∡</u>	Search: Q-					
Peripheral I/O Pins 😂	⊜ (Component Clock Source Requested			Frequ Actual Frequency Range(MH		
MIO Configuration		 Processor/Memory Clocks IO Peripheral Clocks 					
Clock Configuration	E	PL Fabric Clocks					
DDR Configuration		FCLK_CLK0	IO PLL 🔻	100.000000	100.000000	0.100000 : 250.000000	
- SMC Timing Calculatio		FCLK_CLK1	IO PLL	200.000000	200.000000	0.100000 : 250.000000	
SMC TIMING Calculatio		FCLK_CLK2	IO PLL	200.000000	200.000000	0.100000 : 250.000000	
Interrupts		FCLK_CLK3	IO PLL	76.923080	76.923080	0.100000 : 250.000000	
	E	System Debug Clocks					
Timers Timers							

In contrast to Vivado 2003.2, the "Run Block Automation" function will remove all peripherals that are not connected internally or externally in the "design_1" diagram as shown in the following figure. Hence, by generating the corresponding HDL wrapper (see next step), all signals will also be removed automatically in the "processing_system7_0" component of the "design_1.vhd" HDL wrapper. For this reason, we recommend to use manually the "Make external" function in the context menu as it has been described previously (particularly, when you are planning to edit the corresponding HDL wrapper later as it will be also shown later in this step-by-step tutorial)!





9.) Then, the corresponding HDL wrapper is created (1) by chosing the non-default option "Copy generated wrapper to allow user edit" (2):



10.) Before the hardware design can be exported, the "IP Integrator" design has to be generated:



🚴 TE0720_HelloWorld - (D:/Trenz	-Electronic/TE0720_HelloWorld/TE0720_HelloW	orld.xpr] - Viva	do 2013.3				×
File Edit Flow Tools Windo	w Layout View Help					Q- Search commands	
🯄 😂 🔠 in 🕫 🗟 🆍 🗙 🐼	🔈 🕨 🛬 🚳 🐝 🔽 🎼 😬 Default Layout	- X & Y	K Q				Ready
Flow Navigator «	Block Design - design_1						×
Q 🖾 📾	Sources _	. 🗆 🖉 🗙	🎦 Diagram 🛛 🛛 🔀 Addres	s Editor 🗙			o e ×
4 Project Manager	옥 🛣 🛱 😂 谢 🗎 🛃		🖞 🙏 design_1				
Project Natiogen Revenues	Design Sources (1)		*				-
dd Sources	esign_1_wrapper - STRUCTURE (design_1_krapper - STRUCTURE (design_1_i - design_1_krapper - STRUCTURE (design_1_krapper - STRUC	sgn_1_wrap	2		_		
🖵 IP Catalog	E D design_1 - STRUCTURE (design_1.v	Source N	ode Properties	Strg+E			
4 IP Integrator	processing_system/_0 - design_ Gonstraints	Open File	9	Alt+O			
🕂 Create Block Design	E C Simulation Sources (1)	Create H	DL Wrapper				
😚 Open Block Design		View Inst	antiation Template				
🎭 Generate Block Design		Generate	Output Products		1.	processing_system7_0	
 Simulation 		Reset Ou	tput Products			GP10_0 + GP10_0	
Simulation Settings		Export H	ardware for SDK				
Run Simulation		Package	Block Design			FIXED_IO+	
 RTL Analysis 		Replace	File		-	SPI.04	
Open Elaborated Design		Copy File	Into Project			CAN_0+	
 Synthesis 		Copy All	Files Into Project	∆lt+I		-TTC0_CLK0_IN CAN_1+	
🚯 Synthesis Settings		× Remove	File from Project	Entf			
Run Synthesis	•	Enable F	le	Alt+Entspricht		-M_AXI_GP0_ACLK USBIND_0	
P per Synthesized besign	Hierarchy IP Sources Libraries Compile Order	Disable	ile	Alt+Minus		M_AX1_GP0+ The following output products will be	
 Implementation 	Sources B Design Hierarchy	Ulassad	. Hadata	Alternation	_	TTC0_WAVE0_OUT	
Implementation Settings Run Implementation	Source File Properties	nierarch	Vopuale	,		TTC0_WAVE2_OUT - O I A design 1.hd	
Open Implemented Design		W Kerresh H	Herarchy			FCLK_CLK0	
	w design_1.00	IP Hierar	cny	, i		FCLK_RESETO_N	
Program and Debug Bitstream Settings	Location: D:/Trenz-Electronic/TE0720	Set as Ic			-	ZYNQ7 Processing System	
Cenerate Bitstream	Type: Block Designs	Set as Ou	it-of-Context Module				
Open Hardware Manager	Part: No part found	Set File 1	ype				
Launch iMPACT	Size: 5.0 KB Modified: Today at 18:35:30 PM	Set Used	In		_		
	Copied to: <project directory="">/TE072</project>	Edit Con	straints Sets				
	Read-only: No	Edit Sim	ulation Sets			2. Generate Skip	
		Add Sou	rces	Alt+A			-
	General Properties	Go To So	urce	F7			×κ
	Tcl Console					_ [зе×
	The state of the s	nz-Electronic,	TE0720_HelloWorld/TE07	20_HelloWorld.srcs	s/sou	ources_1/bd/design_1/design_1.bd) -top	
	VHDL Output written to : design_1.vho VHDL Output written to : design 1 wr	pper.vhd					
	Wrote : <d: te0720<="" th="" trenz-electronic=""><th>HelloWorld/TE</th><th>720_HelloWorld.srcs/so</th><th>urces_1/bd/design</th><th>_1/de</th><th>design_1.bd></th><th></th></d:>	HelloWorld/TE	720_HelloWorld.srcs/so	urces_1/bd/design	_1/de	design_1.bd>	
	(b) Chake_wrapper: Time (s): cpu = 00:00:0 import files -force -norecurse D:/Tre	<pre>is ; elapsed = inz-Electronic.</pre>	TE0720 HelloWorld/TE07	: peak = 1354.590 20 HelloWorld.srcs	; ga s/sou	<pre>gain = 0.000 ources 1/bd/design 1/bdl/design 1 wrapper.vhd</pre>	
	<pre>update_compile_order -fileset sources</pre>	L1					=
	Save_bd_design						
	⊖Wrote : <d: te0720<="" th="" trenz-electronic=""><th>HelloWorld/TE</th><th>0720_HelloWorld.srcs/so</th><th>urces_1/bd/design_</th><th>_1/de</th><th>iesign_1.bd></th><th>-</th></d:>	HelloWorld/TE	0720_HelloWorld.srcs/so	urces_1/bd/design_	_1/de	iesign_1.bd>	-
	Type a Tcl command here				_		-
	I Tcl Console Messages Log						
Generate HDL files							

11.) Finally, export hardware for SDK (menu "File -> Export -> Export Hardware for SDK...") and launch SDK:

🚴 Export Hardware for SDK							
Export h	Export hardware platform for SDK.						
Options							
Source:	🙏 design_1.bd	Ŧ					
Export to:	Local to Project>	-					
Workspace:	Workspace: 60 <local project="" to=""> *</local>						
Export Ha	Export Hardware						
Include b	Include bitstream (Note: an Implemented design mu						
✓ Launch S	Launch SDK						
OK Cancel							

The exported source "design_1.bd" is a hardware description only and the following files are generated by the Vivado IP Integrator [Xilinx UG898: Embedded Processor Hardware Design (v2013.3), p.41]:

File	Description
system.xml	This file opens by default when you launch SDK and displays the address map of your system.
ps7_init.c	



File	Description
ps7_init.h	The ps7_init.c and ps7_init.h files contain the initialization code for the Zynq Processing System and initialization settings for DDR, clocks, PLLs, and MIOs. SDK uses these settings when initializing the processing system so applications can run on top of the processing system.
ps7_init.tcl	This is the Tcl version of the INIT file.
ps7_init.html	The INIT file describes the initialization data.

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Note: See the "Xilinx UG821: Zynq-7000 All Programmable SoC Software Developers Guide" for more information about generated files.

There is no bitstream required for the follwing simple software "Hello World" application to be executed on the Xilinx Zynq *Processing System* (PS), since the ARM Cortex A9 dual core is already present in the FPGA. Basic initialization of this system to run a simple application is done by the device initialization TCL script.

Only if additionally a Xilinx Zynq *Programmble Logic* (PL) design is required to be configured (e.g., to access the TE0701 on-board HDMI interface), the corresponding bitfile must also be exported to SDK. **Note**: The corresponding option can be selected only when the implemented design has been opened in Vivado! For more details on the synthesis and implementation process, please refer to the later section "Vivado Flow | Hardware Synthesis & Implementation".

Software Implementation: Create First Stage Boot Loader (FSBL) and "Hello World" application project in SDK

1.) After the SDK GUI has been launched, first of all, a new Xilinx Application Project is created. More precisely, a Zynq *First Stage Boot Loader* (FSBL) project:



@® (/C++ - hw_platform_0/system.xml - Xilinx SDK	
File	Edit Source Refactor Navigate Search Run	n Project Xilinx Tools Window Help
	New Alt+Shift+N •	🕨 🄮 Application Project 🛛 🔮 🔯 🖻 🔂 C/C++
	Open File	Board Support Package
	Close Ctrl+W	
	Close All Ctrl+Shift+W	Source Folder An outline is not available.
	Save Ctrl+S	C Source File ≡
9	Save As	Header File
R.	Save All Ctrl+Shift+S	🕆 File from Template
	Revert	Class
	Move	Ctrl+N 1.
	Rename F2	ocessor ps7 cortexa9 0
55	Refresh F5	
	convert Line Delimiters to	1 1 0xf8009000 0xf8009ff
	Print CtrI+P	i 2 0xf800a000 0xf800afff
	Switch Workspace	1_3 0xf800b000 0xf800bfff
	Restart	n_0 0xe0008000 0xe0008fff
2	Import	p_1 0xe0009000 0xe0009fff
4	Export	p_0 0xf8800000 0xf88fffff
	Properties Alt+Enter	
	1 ps7 init.c [hw platform 0]	
	2 system.xml [hw_platform_0]	💷 Console 🛛 🔲 Properties 🧬 Terminal 🛛 🕞 🖬 🛃 🛃 🖝 🖃 🗸 🗂 🗸
	Fxit	
	10.47.4Z 1NFU	Processing command line option -hwspec D:/Trenz-Electronic/ A
		-
	•	4

💀 New
Select a wizard
<u>W</u> izards:
type filter text
 ▷ ☺ General ▷ ☺ C/C++ ▷ ➢ Remote System Explorer ▲ ➢ Xilinx ☑ Application Project 2. ▲ Board Support Package ➡ Hardware Platform Specification
(?) < <u>B</u> ack Next > 3. <u>Einish</u> Cancel



😳 New Project						
Application Project						
Create a managed make application project.						
Project name: TE0720 fsbil 4						
Use default location						
Location: D:\Trenz-Electronic\TE0720_HelloWorld\TE0720_HelloWorld.sdk\SD Browse						
Choose file system: default 💌						
Target Hardware						
Hardware Platform hw_platform_0						
Processor ps7_cortexa9_0						
Target Software						
OS Platform standalone 🗸						
Language 💿 C 💿 C++						
Board Support Package Create New TE0720_fsbl_bsp						
◯ Use existing 🔹						
? < <u>Back</u> <u>Next</u> <u>Finish</u> Cancel						





2.) Secondly, a application project is created, which will be associated with the previously generated Zynq FSBL:





@® (/C++ - hw_platform_0/system.xml - Xilinx SDK	
File	Edit Source Refactor Navigate Search Run	n Project Xilinx Tools Window Help
	New Alt+Shift+N •	🕨 🄮 Application Project 🛛 🔮 🔯 🖻 🔂 C/C++
	Open File	Board Support Package
	Close Ctrl+W	
	Close All Ctrl+Shift+W	Source Folder An outline is not available.
	Save Ctrl+S	C Source File ≡
9	Save As	Header File
R.	Save All Ctrl+Shift+S	🕆 File from Template
	Revert	Class
	Move	Ctrl+N 1.
	Rename F2	ocessor ps7 cortexa9 0
55	Refresh F5	
	convert Line Delimiters to	1 1 0xf8009000 0xf8009ff
	Print CtrI+P	i 2 0xf800a000 0xf800afff
	Switch Workspace	1_3 0xf800b000 0xf800bfff
	Restart	n_0 0xe0008000 0xe0008fff
2	Import	p_1 0xe0009000 0xe0009fff
4	Export	0_0 0xf8800000 0xf88fffff
	Properties Alt+Enter	
	1 ps7 init.c [hw platform 0]	
	2 system.xml [hw_platform_0]	💷 Console 🛛 🔲 Properties 🧬 Terminal 🛛 🕞 🖬 🛃 🛃 🖝 🖃 🗸 🗂 🗸
	Fxit	
	10.47.4Z 1NFU	Processing command line option -hwspec D:/Trenz-Electronic/ A
		-
	•	4

💀 New
Select a wizard
<u>W</u> izards:
type filter text
 ▷ ☺ General ▷ ☺ C/C++ ▷ ➢ Remote System Explorer ▲ ➢ Xilinx ☑ Application Project 2. ▲ Board Support Package ➡ Hardware Platform Specification
(?) < <u>B</u> ack Next > 3. <u>Einish</u> Cancel



🐵 New Project							
Application Project							
Create a managed make	Create a managed make application project.						
Project name: TE0720_H	lelloWorld 4.						
Use default location							
Location: D:\Trenz-Elect	ronic\TE0720_HelloWorld\TE0720_HelloWorld.sdk\SD Browse						
Choose file s <u>v</u> st	iemi default 💌						
Target Hardware							
Hardware Platform hw_	_platform_0						
Processor ps7	_cortexa9_0 🔹						
Target Software							
OS Platform	standalone						
Language							
Board Support Package	Create New TE0720_HelloWorld_bsp						
	Use existing TE0720_fsbl_bsp 5.						
		_					
?	< <u>B</u> ack <u>N</u> ext > <u>F</u> inish Cancel						
	6.						



💀 New Project			
Templates			G
Create one of the avai project.	lable templates to generat	e a fully-functioning application	
Available Templates:			
Dhrystone Empty Application Hello World		Let's say 'Hello World' in C.	^
IwIP Echo Server Memory Tests Peripheral Tests Zynq FSBL	7.		
			~
0	Seck No.	ext > Einish 8	Cancel

3.) Next, the "Hello World" application project can be customized (**Note**: Saving all files (3) will automatically rebuild the project):



C/C++ - TE0720_HelloWorld/sr	c/helloworld.c - Xilinx SDK	
<u>File Edit Source Refactor Na</u>	avigate Se <u>a</u> rch <u>R</u> un <u>P</u> roject <u>X</u> ilinx Tools <u>W</u> indow <u>H</u> elp	
1 ▼ 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	▏	₫ C/C++
Project Explorer 🛛 🗌 🗖	🕼 system.xml 🛛 🕼 system.mss 🔷 *helloworld.c 🛛 👘 🕄	M "1 - D
	<pre>* PS7 UART (Zyng) is not initialized by this application, since * bootrom/bsp configures it to baud rate 115200 * * *</pre>	<pre>↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓</pre>
iscriptio		
	Droplans (@ Tasks (Concole) Droparties @ Terminal)	
	CDT Build Console (TF0720 HelloWorld)	<u> </u>
	make: Für das Ziel wall« ist nichts zu tun.	•
	19:46:31 Build Finished (took 154ms)	≡
		~
	Writable Smart Insert 43 : 19	

4.) Finally, the boot image must be created:



File Edit Source Refac	tor Navigat	e Search Run Project Xil	linx Tools Wi	lindow Help	- 10 m	and the second			
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Output path	D:\Trer	z-Electronic\TE072	0_HelloW	Vorld\TE0720_HelloWorld.sdk\S	DK\SDK_E	xport\TE0720_HelloWorld\bootimag	e\output.bin		Browse
?							Create Ima	ige Ca	ancel
			_		_			3.	

5.) ... and the newly generated boot image "output.bin" (may be renamed to "boot.bin") and copied onto a SD card, which must be formatted with a FAT32 file system.



To learn about how to set up a UART communication channel between the Xilinx Zynq FPGA (UART0) and the host PC, please consult Vivado Flow (Video and Step-by-Step Tutorial) | Debugging the "Hello World" Project.

Hardware Synthesis & Implementation

Starting from this point, we are going to create (similarly to the TE0720 GigZee Zynq SoM | Reference Projects | Base PlanAhead Project, however, the implementation is achieved a little bit differently in Vivado) a custom PS wrapper which communicates with the PS via the EMIO interface and pass I2C signals and one GPIO pin to the on-board CPLD (TE0720 User Manual | System Management Controller). Inside the CPLD, an I2C switch controlled by the GPIO pin X0 is implemented.

1.) Open the previously generated HDL Wrapper "design_1_wrapper.vhd" and comment external I2C1 and GPIO signals and add CPLD signals to the "design_1_wrapper" entity:



VHDL-Code (to copy & paste):

```
-- I2C - CPLD connection
X5 : in STD_LOGIC; -- i2c_sda_in
X7 : out STD_LOGIC; -- i2c_sda_out
X0 : out STD_LOGIC; -- i2c_sw
X1 : out STD_LOGIC; -- i2c_scl_out
-- I2C TE0701
i2c_scl_pin : inout STD_LOGIC; -- TE0701 HDMI SCL
i2c_sda_pin : inout STD_LOGIC -- TE0701 HDMI SDA
```



2.) ... add signals to the architecture section (Note: You may also comment the automatically generated I2C1 and GPIO signals as well as the 32 instantiations of the GPIO tristate signal buffers):

de	sign_1_wrapper.vhd * _ 🗆 🖬	а х
-	D:/Trenz-Electronic/TE0720_HelloWorld/TE0720_HelloWorld.srcs/sources_1/imports/hdl/design_1_wrapper.v	hd
	196 signal GPIO_0_tri_t_24 : STD_LOGIC_VECTOR (24 to 24);	
10	197 signal GPIO_0_tri_t_25 : STD_LOGIC_VECTOR (25 to 25);	
U	198 signal GPIO_0_tri_t_26 : STD_LOGIC_VECTOR (26 to 26);	
do	199 signal GPIO_0_tri_t_27 : STD_LOGIC_VECTOR (27 to 27);	
B	200 signal GPIO_0_tri_t_28 : STD_LOGIC_VECTOR (28 to 28);	
1	<pre>201 signal GPIO_0_tri_t_29 : STD_LOGIC_VECTOR (29 to 29);</pre>	
	<pre>202 signal GPIO_0_tri_t_3 : STD_LOGIC_VECTOR (3 to 3);</pre>	
X	203 signal GPIO_0_tri_t_30 : STD_LOGIC_VECTOR (30 to 30);	
//	204 signal GPIO_0_tri_t_31 : STD_LOGIC_VECTOR (31 to 31);	
	205 signal GPIO_0_tri_t_4 : SID_LOGIC_VECTOR (4 to 4);	
	200 signal GPIO_0_tri3: SID_LOGIC_VECTOR (5 to 5);	
	200 Signal GPIO_U_TI_L_0 : SID_LOGIC_VECTOR (0 to 0);	
đ	200 signal GPIO_0_tri_t & STD_LOGIC_VECTOR (8 to 8):	
m	210 signal GPTO 0 tri t 9 : STD LOGIC VECTOR (9 to 9):	
-	211 signal IIC 1 scl i : STD LOGIC:	-
V	212 signal IIC 1 scl o : STD LOGIC;	-
P	213 signal IIC 1 scl t : STD LOGIC;	=
-	214 signal IIC 1 sda_i : STD_LOGIC;	
Ĩ	<pre>215 signal IIC_1_sda_o : STD_LOGIC;</pre>	
×	216 signal IIC_1_sda_t : STD_LOGIC;	
	<pre>217 signal gpio_i : STD_LOGIC_VECTOR(31 downto 0);</pre>	
	218 signal gpio_o : STD_LOGIC_VECTOR(31 downto 0);	
	<pre>219 signal gpio_t : STD_LOGIC_VECTOR(31 downto 0);</pre>	
	220 signal ps_i2c_sda_i : STD_LOGIC;	
	221 signal ps_12c_sda_o : STD_LOGIC;	
	222 signal ps_12c_sda_t : STD_LOGIC;	
	223 signal ps_12c_scl_1 : STD_DUGIC;	
	224 Signal ps_12c_SCL_0 : SiD_DUGIC;	
	226 begin	
	227 GPIO 0 tri iobuf 0: component IOBUF	
	228 port map (
	229 I => GPIO 0 tri 0 0(0),	
	230 IO => GPIO_0_tri_io(0),	
	231 0 => GPIO_0_tri_i_0(0),	
	232 T => GPIO_0_tri_t_0(0)	
	233);	
	234 GPIO_0_tri_iobuf_1: component IOBUF	
	235 port map (
	236 I => GPIO_0_tri_0_1(1),	
	237 IO => GPIO_0_tri_io(1),	
	238 0 => GPIO_0tri_i_1(1),	
	$239 - 1 \Rightarrow GFIO_0 tr1_t_1(1)$	
	240 1;	-
	<	P

VHDL-Code (to copy & paste):

```
signal ps_i2c_sda_i : STD_LOGIC;
signal ps_i2c_sda_o : STD_LOGIC;
signal ps_i2c_sda_t : STD_LOGIC;
signal ps_i2c_scl_i : STD_LOGIC;
signal ps_i2c_scl_o : STD_LOGIC;
signal ps_i2c_scl_t : STD_LOGIC;
signal gpio_i : STD_LOGIC_VECTOR(31 downto 0);
signal gpio_o : STD_LOGIC_VECTOR(31 downto 0);
signal gpio_t : STD_LOGIC_VECTOR(31 downto 0);
```

3.) ... replace the port mapping of GPIO (i.e., by commenting the 32 GPIO_0_tri_i, 32 GPIO_0_tri_o, and 32 GPIO_0_tri_t port mappings and replacing them by the corresponding GPIO vectors) as well as I2C1:



de	sign_1_wr	apper.vhd * 🛛 🗆 🖉 🖉		
123	D:/Trenz	-Electronic/TE0720_HelloWorld/TE0720_HelloWorld.srcs/sources_1/imports/hdl/design_1_wrapper.vhd		
	465 design 1 i: component design 1			
6	466 port map (
01	467	DDR addr(14 downto 0) => DDR addr(14 downto 0),		
A	468	DDR ba(2 downto 0) \Rightarrow DDR ba(2 downto 0),		
0	469	DDR cas n => DDR cas n,		
	470	DDR ck n => DDR ck n,		
	471	DDR ck p => DDR ck p,		
X	472	DDR cke => DDR cke,		
11	473	DDR_cs_n => DDR_cs_n,		
	474	DDR_dm(3 downto 0) => DDR_dm(3 downto 0),		
	475	DDR_dq(31 downto 0) => DDR_dq(31 downto 0),		
	476	DDR_dqs_n(3 downto 0) => DDR_dqs_n(3 downto 0),		
-	477	DDR_dqs_p(3 downto 0) => DDR_dqs_p(3 downto 0),		
CE I	478	DDR_odt => DDR_odt,		
Ð	479	DDR_ras_n => DDR_ras_n,		
0	480	DDR_reset_n => DDR_reset_n,		
	481	DDR_we_n => DDR_we_n,		
	482	FIXED_IO_ddr_vrn => FIXED_IO_ddr_vrn,		
-	483	<pre>FIXED_I0_ddr_vrp => FIXED_I0_ddr_vrp,</pre>		
j.	484	<pre>FIXED_IO_mio(53 downto 0) => FIXED_IO_mio(53 downto 0),</pre>		
—	485	FIXED_IO_ps_clk => FIXED_IO_ps_clk,		
	486	FIXED_I0_ps_porb => FIXED_I0_ps_porb,		
	487	FIXED_IO_ps_srstb => FIXED_IO_ps_srstb,		
	488	<pre>GPIO_0_tri_i(31) => GPI0_0_tri_i_31(31),</pre>		
	489	<pre>GPIO_0_tri_i(30) => GPIO_0_tri_i_30(30),</pre>		
	490	GPIO_0_tri_i(29) => GPIO_0_tri_i_29(29),		
	582	GPI0_0_tri_t(1) => GPI0_0_tri_t_1(1),		
	583	$GPIO_0 tri_t(0) \implies GPIO_0 tri_t_0(0),$		
	584	IIC_1_scl_1 => IIC_1_scl_1,		
	565	IIC_I_SCI_0 => IIC_I_SCI_0,		
	500	$IIC_I_SCI_t \Rightarrow IIC_I_SCI_t,$ $IIC_I_sci_t \Rightarrow IIC_I_ada i$		
	588	$IIC 1 eda = \sum IIC 1 eda = 0$		
	589	$IIC_1 = da_1 = \sum IIC_1 = da_1$		
	590	GPIO 0 tri i => gpio i.		
	591	GPIO 0 tri $o \Rightarrow gpio_1$,		
	592	GPIO 0 tri t => gpio_t		
	593	IIC 1 scl i => ps i2c scl i.		
	594	IIC 1 scl o => ps i2c scl o.		
	595	IIC 1 scl t => ps i2c scl t,		
	596	IIC 1 sda i => ps i2c sda i,		
	597	IIC 1 sda o => ps i2c sda o,		
	598	<pre>IIC 1 sda t => ps i2c sda t,</pre>		
	599);	Ξ	
	600 end	STRUCTURE;		
			T	
	•			

VHDL-Code (to copy & paste):

GPI0_0_tri_i => gpio_i, GPI0_0_tri_o => gpio_o, GPI0_0_tri_t => gpio_t, IIC_1_scl_i => ps_i2c_scl_i, IIC_1_scl_t => ps_i2c_scl_o, IIC_1_scl_t => ps_i2c_scl_t, IIC_1_sda_i => ps_i2c_sda_i, IIC_1_sda_t => ps_i2c_sda_t



4.) ... and finally, some "glue" logic has to be added to the architecture section:

de	sign_1_w	rapper.vhd *	2	×
	D:/Tren	z-Electronic/TE0720_HelloWorld/TE0720_HelloWorld.srcs/sources_1/imports/ho	dl/design_1_wrapper.vhd	
-	586	<pre>IIC_1_scl_t => IIC_1_scl_t,</pre>		
	587	<pre>IIC_1_sda_i => IIC_1_sda_i,</pre>		
01	588	<pre>IIC_1_sda_o => IIC_1_sda_o,</pre>		
20	589	IIC_1_sda_t => IIC_1_sda_t		
E	590	GPIO_0_tri_i => gpio_i,		
150	591	GPIO_0_tri_o => gpio_o,		
	592	GPIO_0_tri_t => gpio_t,		
X	593	<pre>IIC_1_scl_i => ps_i2c_scl_i,</pre>		
//	594	<pre>IIC_1_scl_o => ps_i2c_scl_o,</pre>		
-	595	<pre>IIC_1_scl_t => ps_i2c_scl_t,</pre>		
-	596	<pre>IIC_1_sda_i => ps_i2c_sda_i,</pre>		
	597	<pre>IIC_1_sda_o => ps_i2c_sda_o,</pre>		
A	598	<pre>IIC_1_sda_t => ps_i2c_sda_t</pre>		
	599);		
de	600	glue logic for I2C and GPIO		
	601	gp10_1 <= x"123456/8";	Stub for GPIO input signals	
100	602	xu <= not gpio_0(U);	12C bus switch control signal	
-	603	ps_12c_sda_1 <= X5 and 12c_sda_pin;	SDA in	
4	604	ps_12c_sci_1 <= ps_12c_sci_0 or ps_12c_sci_t;	SCL TEEDDACK	
-	605	X/ <= ps_12C_sda_0 or ps_12C_sda_t;	CPLD SDA	
-	606	<pre>12c_sda_pin <= ps_12c_sda_o when (ps_12c_sda_t = '0') eise '2';</pre>	ILU/UI SDA	
	607	AI <= ps_12c_sci_0 or ps_12c_sci_t;	TEOROI SCI	
	609 end	STDUCTUDE -	150/01 201	-
	dus end	STRUCTURE,	•	

VHDL-Code (to copy & paste):

```
-- glue logic for I2C and GPIO
gpio_i <= x"12345678";</pre>
                                                 -- Stub for GPIO input signals
X0 <= not gpio_o(0);</pre>
                                                 -- I2C bus switch control sign;
ps_i2c_sda_i <= X5 and i2c_sda_pin;</pre>
                                                 -- SDA in
ps_i2c_scl_i <= ps_i2c_scl_o or ps_i2c_scl_t; -- SCL feedback</pre>
X7 <= ps_i2c_sda_o or ps_i2c_sda_t;
                                                 -- CPLD SDA
i2c_sda_pin <= ps_i2c_sda_o
when (ps_i2c_sda_t = '0') else 'Z';
                                                -- TE0701 SDA
X1 <= ps_i2c_scl_o or ps_i2c_scl_t;</pre>
                                                 -- CPLD SCL
i2c_scl_pin <= ps_i2c_scl_o or ps_i2c_scl_t; -- TE0701 SCL
```

5.) Create a new XDC constraint file and add the following XDC constraint file "design_1_wrapper.xdc":







& Add Sources		X
Add or Create Constraints	s	
specify of create constru		
Specify constraint set:	constrs_1 (active)	
Constraint File	Location	
design_1_wrapper.xdc	D:\Users\Sven-Ole Voigt\Downloads 5.	
		\mathbf{X}
	Add Files	
Copy constraints files in	to project 6. 4.	
	7.	
	< <u>B</u> ack <u>N</u> ext > <u>Finish</u>	Cancel

Generally, if you would like to use an "old" UCF file, you may use our following perl script (which follows the instructions of the Xilinx UG911 (v2013.3) "ISE-Vivado Design Suite Migration Guide"; see section "UCF to XDC Mapping", p.23) to easily convert the physical constraints from an existing UCF input file:

```
#-- Copyright (c) 2014 by Trenz Electronic.
#-- Holzweg 19a, 32257 Buende, Germany, www.trenz-electronic.de
#-- Project: TE07xx Series
#-- File: ucf2xdc.pl
#-- Description: Perl script to convert Xilinx ucf to xdc contraint files.
#-- History: 2014-01-07, SOV, Created.
open(IN, 'input.ucf');
open(OUT,'> output.xdc');
while ($line = <IN>) {
  # remove leading, trailing and multiple spaces
  $line =~ s/^ //g;
  $line =~ s/ $//g;
  $line =~ s/ / /g;
```



```
# comment or empty lines are simple copied without any modification
    if ((substr($line,0,1) =~ "#") || (substr($line,0,1) =~ "\n")){
       print OUT $line;
    }
   else {
        if ($line =~ /(?<=NET )\w*/){
            \$NET = \$&;
            if ($line =~ /(?<=LOC = )\w*/){
                # UCF: NET "<net_name>" LOC = <pin_name>
                #
                       -> XDC: set_property PACKAGE_PIN <pin_name>
                       [<get_ports net_name>]
                #
                \LOC = \&\&;
                print OUT "set_property " . "PACKAGE_PIN " . $LOC . "
                [get_ports " . $NET . "]" . "\n";
            }
            if ($line =~ /(?<=IOSTANDARD = )w^*/){
                # UCF: NET "<net_name>" IOSTANDARD = <iostandard_type>
                #
                       -> XDC: set_property IOSTANDARD <iostandard_type>
                #
                       [<get_ports net_name>]
                \$IOSTANDARD = \$\&;
                print OUT "set_property " . "IOSTANDARD " . $IOSTANDARD
                . " [get_ports " . $NET . "]" . "\n";
            }
        }
   }
}
close(OUT);
close(IN);
```

6.) To synthesize and implement the "Hello World" project, you just have to click on the "Run Implementation" button. **Note**: Whenever the synthesis is out-of-date, it will be asked if it should be done first:



TE0720_HelloWorld - [D:/Trenz-Electronic/TE0720_HelloWorld/TE0720_HelloWorldxpr] - Vivado 2013.3			
File Edit Flow Tools Wind	ow Layout View Help	Qr Search commands	
🯄 😂 🖽 🗠 🕫 🖳 🐂 🗙 🚸	🔊 🕨 🖄 🕼 🥝 🚳 🐝 🔽 👰 🖽 1/0 Planning 🚽 🖉 🚸 🔌 🕸	Synthesis and Implementation Out-of-Date more info	
Flow Navigator «	Implemented Design - xc7z020clg484-2 (active)	x	
🔍 🛣 🖨	Sources	esign_1_wrapper.xdc ×	
Flow Nexigator	Implemented Design is 202006/94 2 (active) Sources Sou	design_l_wrapper.xdc x belogn_l_wrapper.xdc x	
Synthesis Synthesis Synthesis Settings Synthesis Settings Synthesised Design Synthesized Design Synthesized Design Synthesetation Synthementation Synthemetation Sy	def defignwrapper.thd Location: D:/Trenz-Electronic/TE0720_HelloWorld/TE0720_HelloWorld.srcs/sourcesI/mports/hdl Type: ViOL Library: work Size: 24.0 X8 Moding: Monday 06.01.14 06:26:03 PM Constant for: Schaft Disectoro.ZE0720_HelloWorld.srcs/sourcesI/bd/design_1/hdl/design_1_wrapper.hdl Tppmentation Dr2D_HelloWorld/TE0720_HelloWorld.srcs/sourcesI/bd/design_1/hdl/design_1_wrapper.hdl Tppmentation Provide In Synthesis is Out-of-date Synthesis is Out-of-date Synthesis completes. Synthesis completes. Don't show this delog agent	<pre>2 **</pre>	
	General Properties 2 Yet Bo Concel Design Runs Part Constraints Strategy Name Name Part Constraints Name Part Constraints Strategy Name Name Part Constraints Name Name Part Vivedo Synthesis Defaults (Wixedo Synthesis 2013) Name Name Name Name Name Name Name Name Name Name Name Name Name Name Name Name Name Name Name Name Name Name Name Name Name Name Name Name Name Name Name Name Name Name Name	49 + 10_1142_72_34: * Latus Progress Start Elapsed Folded Routes WNS TNS W Wheles Out-of-date 100% 1/7/14 9:37 PM 00:00:46 1 0.000 0.000	

7.) After some time the synthesis and implementation processes complete and the following dialog windows with about 80 critical warnings appear. That is fine, because the XDC contraint file given consists of many more ports than we used in this simple "Hello World" project (e.g., X2, X3, X4, X6 etc.), so you can relax and press "ok":

🚴 Launch Run Critical Messages	
There were 80 critical warning messages launching implementation run.	
Messages	-
Common 17-55] 'set_property' expects at least one object. [D:/Trenz-Electronic/TE0720_HelloWorld/TE0720_HelloWorld.srcs/constrs_1/imports/Downloads/design_1_wrapper.xdc:35]	
Common 17-55] 'set_property' expects at least one object. [D:/Trenz-Electronic/TE0720_HelloWorld/TE0720_HelloWorld.srcs/constrs_1/imports/Downloads/design_1_wrapper.xdc:36]	
Common 17-55] 'set_property' expects at least one object. [D:/Trenz-Electronic/TE0720_HelloWorld/TE0720_HelloWorld.srcs/constrs_1/imports/Downloads/design_1_wrapper.xdc:38]	=
Common 17-55] 'set_property' expects at least one object. [D:/Trenz-Electronic/TE0720_HelloWorld/TE0720_HelloWorld.srcs/constrs_1/imports/Downloads/design_1_wrapper.xdc:39]	- 11
Common 17-55] 'set_property' expects at least one object. [D:/Trenz-Electronic/TE0720_HelloWorld/TE0720_HelloWorld.srcs/constrs_1/imports/Downloads/design_1_wrapper.xdc:41]	
Common 17-55] 'set_property' expects at least one object. [D:/Trenz-Electronic/TE0720_HelloWorld/TE0720_HelloWorld.srcs/constrs_1/imports/Downloads/design_1_wrapper.xdc:42]	
Common 17-55] 'set_property' expects at least one object. [D:/Trenz-Electronic/TE0720_HelloWorld/TE0720_HelloWorld.srcs/constrs_1/imports/Downloads/design_1_wrapper.xdc:47]	
Common 17-55] 'set_property' expects at least one object. [D:/Trenz-Electronic/TE0720_HelloWorld/TE0720_HelloWorld.srcs/constrs_1/imports/Downloads/design_1_wrapper.xdc:48]	
Common 17-55] 'set_property' expects at least one object. [D:/Trenz-Electronic/TE0720_HelloWorld/TE0720_HelloWorld.srcs/constrs_1/imports/Downloads/design_1_wrapper.xdc:53]	
Common 17-55] 'set_property' expects at least one object. [D:/Trenz-Electronic/TE0720_HelloWorld/TE0720_HelloWorld.srcs/constrs_1/imports/Downloads/design_1_wrapper.xdc:54]	
Common 17-55] 'set_property' expects at least one object. [D:/Trenz-Electronic/TE0720_HelloWorld/TE0720_HelloWorld.srcs/constrs_1/imports/Downloads/design_1_wrapper.xdc:57]	
Common 17-55] 'set_property' expects at least one object. [D:/Trenz-Electronic/TE0720_HelloWorld/TE0720_HelloWorld.srcs/constrs_1/imports/Downloads/design_1_wrapper.xdc:58]	
Common 17-55] 'set_property' expects at least one object. [D:/Trenz-Electronic/TE0720_HelloWorld/TE0720_HelloWorld.srcs/constrs_1/imports/Downloads/design_1_wrapper.xdc:63]	
Common 17-55] 'set_property' expects at least one object. [D:/Trenz-Electronic/TE0720_HelloWorld/TE0720_HelloWorld.srcs/constrs_1/imports/Downloads/design_1_wrapper.xdc:64]	-
🛛 🕛 [Common 17-55] 'set_property' expects at least one object. [D:/Trenz-Electronic/TE0720_HelloWorld/TE0720_HelloWorld.srcs/constrs_1/imports/Downloads/design_1_wrapper.xdc:66] 🔲	ווכ
	-
OK Cancel Run Open Messages View	

8.) Then, another dialog window appears. Keep the default selection that opens the implemented design:





9.) After the implemented design has been opened you can check on I/O ports if the constraints have been configured correctly (1) and when everything is accurate, the bitfile can be finally generated (2):



10.) As soon as the bitfile has been successfully generated, in another dialog window you can choose to launch Xilinx iMPACT to program your FPGA device:



TE0720_HelloWorld - [D:/Trenz	-Electronic/TE0720_HelloWorld/TE0720_HelloWorld.xpr] - Viva	do 2013.3	
File Edit Flow Tools Windo	w Layout View Help		Q. Search commands
🯄 😂 i in 🕫 🗎 🐘 🗙 🔈 🕨	🐮 🌀 🐝 ∑ 🥥 🔚 Default Layout 💿 🗶 🔖 🍾 🎨		write_bitstream Complete
Flow Navigator «	Project Manager - TE0720_HelloWorld		X
🔍 🛣 🛱	Sources _ D 2 ×	E Project Summary ×	다 년 ×
Project Manager Project Settings Add Sources F Catalog F Catalog F Integrator Create Block Design	Second Sec	Toppect Sattings Project name: TE0720_HelloWorld Product family: 2/mq7/000 Product part: xx7x015/cg485-2 Top module name: degn 1_wrapper Synthesis A	Edit *
Open Block Design Generate Block Design Simulation Gisimulation Settings Qi Run Simulation RTL Analysis Den Elaborated Design		Status: V Complete Messoger: 0 153 varings Part: v: 2720201949-2 Strategy: Vivedo Synthesis Defaults Bitstream Generation Completed I Bitstream Generation Successfully completed.	Status: V Complete Messages: 0 160 critical warmings 0 150 warmings Part: xr220205q949-2 Strategy: Vivedo Implementation Defaults Incormental Complex Itone [Summary] Route Status]
 Synthesis Synthesis Settings R nn Synthesis Den Synthesized Design Implementation Implementation Settings R nn Implementation B 20 Cent Implementation 	III III	URC VARIADIDS Summary:	Timing information is not available because it hasn't been run Post-Synthesis [Post-Implementation]
 Program and Debug ⊕ Bistoream Settings ↑	Coulder Development (Could House Head House) Ultrary: work Ultrary: work Stree: 2 44 0 K8 Modified: Todys t 19:23:50 PM Copied to: Arroject Directory / E0/20, HelloWorld s: Copied on: Dr/Tretz-Electomor/TE0/20, HelloWorld/T Copied on: Fride 03.01.14 02:25:34 PM Read-only: No ■ Inabled	Utilization OK Cancel	Power x Total On-Chip Power: 1.458 W Junction Temperature: 41.8 °C Thermal Mergin: 43.2 °C (3.6 W) Effective d3A: 1.15 °C/W Power supplied: 01-Chip dvices: On-Chip Loss Summary On-Chip
	Ganard Properties	Post-Synthesis Post-Implementation	
	Concros resperites		
	LOS [1570: [Vivido 12-1642] Bitgen Completed Successfully, [3] [NTD: [Forgets 1-100] NeDTalk data collection is made [NTD: [Common 17-163] NeDTalk report has not been een [NTD: [Common 17-163] NeDTalk report has not been een write_bitzersm: Time (s) cogn = 0050021 ; elapsed = INTO: [Common 17-206] Exiting Vivado at Wed Jan 08 20	atory for users of free Webpack licenses. To see the specific WebTalk data collected t to Xilinx. Flease check your network and proxy settings. n 0000027 . Memory (MB); peak = 1117.711 ; gain = 353.180 122:23 2014	cor your design, open the usage_statistics_webtalk.html or usage_statistics_webtalk.
	•	III	• • • • • • • • • • • • • • • • • • •
	Synthesis Implementation Simulation		
	📓 Td Console 🔎 Messages 🔍 Log 😩 Reports 🖎 Design Runs		

11.) In Xilinx iMPACT the project's bitfile "design_1_wrapper.bit" has already been automatically assigned to the xc7z020 target (i.e., the PL of the Xilinx Zynq FPGA). After selecting it (1), you can choose in the main menu "Operations" to finally program the FPGA (2):



🐉 ISE iMPACT (P.20131013) - D:\Trenz-Electronic\TE0720_HelloWorld\TE0720_HelloWorld.ipf - [Boundary Scan]			
🐼 File Edit View Operations Output Debug Window Help	_ <i>B</i> ×		
🗋 🍺 🖥 🖌 🗈 🎼 Program 2.			
iMPACT Flows Get Device ID ↔ □ ₽ ×			
Boundary Scan Get Device Signature/Usercode			
Create PROM F	TDI Exume Target 1.		
WebTalk Data One Step XSVF			
Access eFUSE Registers	ynq7000_arm_da xc7z020		
	TDO		
iMPACT Processes ↔ □ 제 X			
Available Operations are:			
➡ Program	Thurtfer Original a		
➡ Get Device ID	Identify Succeeded		
Get Device Signature/Usercode			
➡ One Step SVF	Boundary Scan		
Console	(, , , , , , , , , , , , , , , , , , ,		
<pre>OINFO:iMPACT - Digilent Plugin: User Name: TEO</pre>	701-02		
QINFO: iMPACT - Digilent Plugin: Product Name:	JTAG-ONB4		
QINFO: iMPACT - Digilent Plugin: Serial Number:	251633000016		
DINFO: MPACT - Digilent Plugin: Product ID: 50	800157		
()INFO: iMPACT - Digilent Plugin: JTAG Port Numb	er: 0		
<pre>@INFO:iMPACT - Digilent Plugin: JTAG Clock Fre</pre>	quency: 10000000 Hz		
UINFO: MPACT - Current time: 08.01.2014 20:48:	20		
Identifying chain contents'0': : Manufactu	rer's ID = Xilinx xc7z020, Version : 2		
DINFO: IMPACT: 1777 -			
Reading C:/Xilinx/14.7/LabTools/LabTools/zyng	//data/xc7z020.bsd		
DINFO:IMFACT - Using cseadapterbsberice			
11. Manufacturoris ID - Viling gung7000 arm dan Warsion : 4			
<pre>OINFO:iMPACT:501 - '1': Added Device UNKNOWN successfully.</pre>			
QUNEO:IMPACT:1/// - Reading C:/Xilinx/14.7/LabTools/LabTools/zvng/data/zvng7000_arm_dap_bsd			
()INFO: iMPACT: 1777 -	//ddcd/2ynd/000_dim_ddp.b5d		
Reading C:/Xilinx/14.7/LabTools/LabTools/zyng	/data/zynq7000_arm_dap.bsd		
PROGRESS END - End Operation.			
Elapsed time = 1 sec.			
'2': Loading file 'D:/Trenz-Electronic/TE0720_HelloWorld/TE0720_HelloWorld.runs/impl_1/design_1_wr			
QINFO: iMPACT - Using CseAdapterBSDevice			
DINFO: iMPACT: 2257 - Startup Clock has been changed to 'JtagClk' in the bitstream stored in memory,			
but the original bitstream file remains unchanged.			
<pre>OINFO:iMPACT:501 - '2': Added Device xc7z020 s</pre>	<pre>OINFO:iMPACT:501 - '2': Added Device xc7z020 successfully.</pre>		
Setting Target Device to Mode:BS, Device posi	tion 1.		
< III	4		
🗐 Console 🔇 Errors 🔬 Warnings			
	Configuration JTAG-ONB4 10000000		

A successful FPGA configuration can only be seen (for now) by checking if the green LED3 (see TE0720 GigaZee Zynq SoM User Manual | On-board LEDs) has switched off. Because this is admittedly quite a bit unsatisfying, in the following section we will extend our "Hello World" application by a I2C software driver on a standalone platform and afterwards our tutorial will



continue on "How to run an embedded Linux system on TE0720 GigaZee Zynq SoM (Vivado Flow)".

Software Implementation: "Hello World 2.0" (implementing access to I2C peripherals via Xilinx Zynq PL custom logic)

Debugging the "Hello World" Project

Video Tutorial

The following screen-recording video shows how to execute "Hello World" from the debugger (Xilinx XMD launched from SDK):

Step-by-Step Tutorial

The simple "Hello World" application above shall now be executed step-by-step in the SDK environment:

1.) Plug-in 12V power supply.

2.) Plug a standard USB A-Male to Mini-B cable into the USB port of the Host PC and into the mini USB connector (see (19) in Figure 1 of TE0701 Carrier for TE07xx series) on the TE0701 carrier board.

3.) Optional: Plug-in the SD card (see section "Software Implementation: Create *First Stage Boot Loader* (FSBL) and *"Hello World"* application project in SDK") into the slot on the TE0701 Carrier board.

4.) Create a new terminal connection to the virtual COM of the FTDI USB Converter (channel B) and choose the following settings:



New Terminal	Connection	
View Settings:		
View Title: Ter	rminal 1	
Encoding: ISC)-8859-1 -	
Connection Typ	pe:	
Serial	-	
Settings:		
Port:	COM3 👻	
Baud Rate:	115200 -	
Data Bits:	8 -	
Stop Bits:	1 -	
Parity:	None 👻	
Flow Control:	None 👻	
Timeout (sec):	5	
OK Cancel		

5.) Press the "Connect" button (1) and the "Hello world" output will shortly appear:

		×
P Terminal 1	1. 💦 ស 🔳 🛱 🚮 🖉 🗸	🖬 🗕 🗶
Serial: (COM3, 115200, 8, 1, None, None - CLOSED) - Encoding: (ISO-8859-1)	Connect	
Hello TE0720 :)		~
		-

The software application (when running from the SD card) might have already finished execution, so you may push the S2 switch button on the TE0701 Carrier Board (see (17) in Figure 1 of TE0701 Carrier Board User Manual) to "restart" the Zynq SoC Module (see TE0701 Carrier Board User Manual) to "restart" the Zynq SoC Module (see TE0701 Carrier Board User Manual) to "restart" the Zynq SoC Module (see TE0701 Carrier Board User Manual) to "restart" the Zynq SoC Module (see TE0701 Carrier Board User Manual) to "restart" the Zynq SoC Module (see TE0701 Carrier Board User Manual) to "restart" the Zynq SoC Module (see TE0701 Carrier Board User Manual) to "restart" the Zynq SoC Module (see TE0701 Carrier Board User Manual) to "restart" the Zynq SoC Module (see TE0701 Carrier Board User Manual) to "restart" the Zynq SoC Module (see TE0701 Carrier Board User Manual) to "restart" the Zynq SoC Module (see TE0701 Carrier Board User Manual) to "restart" the Zynq SoC Module (see TE0701 Carrier Board User Manual) to "restart" the Zynq SoC Module (see TE0701 Carrier Board User Manual) to "restart" the Zynq SoC Module (see TE0701 Carrier Board User Manual) to "restart" the Zynq SoC Module (see TE0701 Carrier Board User Manual) to "restart" the Zynq SoC Module (see TE0701 Carrier Board User Manual) to "restart" the Zynq SoC Module (see TE0701 Carrier Board User Manual) to "restart" the Zynq SoC Module (see TE0701 Carrier Board User Manual) to "restart" the Zynq SoC Module (see TE0701 Carrier Board User Manual) to "restart" the Zynq SoC Module (see TE0701 Carrier Board User Manual) to "restart" the Zynq SoC Module (see TE0701 Carrier Board User Manual) to "restart" the Zynq SoC Module (see TE0701 Carrier Board User Manual) to "restart" the Zynq SoC Module (see TE0701 Carrier Board User Manual) to "restart" the Zynq SoC Module (see TE0701 Carrier Board User Manual) to "restart" the Zynq SoC Module (see TE0701 Carrier Board User Manual) to "restart" the Zynq SoC Module (see TE0701 Carrier Board User Manual) to "restart" the Zynq S

6.) Of course, you can also download the same or a different application onto the running *processing unit* (PS) of the Zynq FPGA:





7.) ... and the program execution is (by default) halted in the beginning of "main". By pressing F6 on the keyboard you can debug your program step-by-step:



Debug - TE0720_HelloWorld/src/helloworld.c - Xilinx SDK		_				x
Eile Edit Source Refactor Navigate Search Run Project Xilinx Tools Window Help						
] 😒 등 ei 9. © .€ 14 = 0 ≪ & & = 0 + Q + Q + Q + (0 = 0 = 0 = + 1	a 🏶 📓 🚯	🔊 🛷 👻 🍠	🛃 🕶 😽 🖛 😓 🗇	▼ ⇔ ▼	🗈 🕸 Debug	>>
🏇 Debug 🕴 🙀 📴 🍸 🗖	🗆 🔠 Outline 🖾			F	 <u> } ≥ ≈ ≈ ∼ ⊏</u>	
A RM Cortex-A9 MPCore #0 (Breakpoint)	 stdio. 	h				
\equiv 0x0010054c main():/src/helloworld.c. line 40	platfo	orm.h				- 1
\equiv 0x001006f0 start(): xil-crt0.S, line 149	+ print(char*) : void				- 1
ARM Cortex-A9 MPCore #1 (Suspended)	• main() : int				- 1
≡ 0xfffff34	=					- 1
≡ 0xfffff2c						- 1
≡ 0xffffff2c	T					
🗈 helloworld.c 🗵 🖻 platform.c 🛛 🖍 system.mss	🕬= Variables 💁	Breakpoints 🔐 Re	egisters 🛛 🛋 Moo	dules 🔯 XMD Cons	ole	
👻 * Copyright (c) 2009-2012 Xilinx, Inc. All rights reserved.					🗄 🍕 🖻 🗟 📑 🖻	
- /*	Name	Hex	Decimal	Description	Mnemonic	
* helloworld c: simple test application	lili rO	00000000	0			
*	1000 r1	0000000	0			
* This application configures UART 16550 to baud rate 9600.	iiii r2	00108060	1081440			
* PS7 UART (Zyng) is not initialized by this application, sin	388 r3	001004 f 4	1049844			
* <u>bootrom/bsp</u> configures it to baud rate 115200	1010 r4	0000003	3			
*	1919 r5	0000001e	30			_
* UART TYPE BAUD RATE	1111 r6	0000ffff	65535			
*	8161 r7	fffffff	4294967295			_
* uartns550 9600	8101 r8	00000000	0			
* uartlite Configurable only in HW design	6161 r9	++++++++	4294967295			
* ps/_uart 115200 (configured by pootrom/bsp) */	0101 r10	00000000	0			-
	0101 [1]	00000000	1007909			
<pre>#include <stdio.h></stdio.h></pre>	1918 60	00102050	1097824			-
<pre>#include "platform.h"</pre>	lill Ir	00100650	1050352			
unid mint/abou *stal.	lill pc	0010054c	1049932			
void print(char "str);		600001df	1610613215			
⊖int main()	⊳ lilii usr					
≥ { ·	⊳ IIII fiq					
<pre>init_platform();</pre>	▶ 1919 irq					
<pre>print("Uplle_TE0720 +))p)p");</pre>	⊳ 배 abt					
	▷ 號 und					
return 0;	▶ 1010 SVC					
	⊳ 號 mon					
	⊳ 🚻 vfp					
	▷ 배 cp15					
· · · · · · · · · · · · · · · · · · ·	▷ IIII Jazelle					
• III •						* *
📮 Console 🖉 Tasks 🖹 Problems 🚺 Executables 🚺 Memory 🖉 Terminal 1 🛛				NN 🕅 🗖 🌆	👔 🖉 🔻 📑 🕶 🗶 🗆	
Serial: (COM3, 115200, 8, 1, None, None - CONNECTED) - Encoding: (ISO-8859-1)						
						-
						Ψ.
□* Writable	Smart I	nsert 40:2				
		1				



FPGA design without PS

TE0720 is a Zynq-7000 SoC based module, and it is normally used with the PS subsystem enabled and included in the design. Of course, it is also possible to use the TE0720 without instantiating the PS in the design. Such a design can be downloaded into the module through the JTAG port (in a volatile way). It can also be stored to (in a non-volatile way) and loaded at configuration time from QSPI, eMMC or SD Card.

CLLK, otherwise the SoC bitstream will not be enabled when configured by FSBL.

The regular FSBL is able to configure the Zynq PL fabric with a design without any PS instance, but a special compile-time flag **NON_PS_INSTANTIATED_BITSTREAM** must be defined.

If executing from a SD memory card, FSBL must have the DDR memory initialized properly, otherwise the PL configuration fails, as FSBL copies the SoC bitstream from the SD memory card to a temporary DDR location!



Xilinx repository

LEPRECATED - use petalinux 2014.2 or newer and TE0720 BSP

Using official Xilinx linux kernel repository with TE0720

This patch was tested only with kernel 3.10 (commit efc27505715e64526653f35274717c0fc56491e3)

A Known issues:

• QSPI Flash not working in u-boot

Clone linux-xlnx and u-boot-xlnx repositories to prepared environment

git clone git://github.com/Xilinx/u-boot-xlnx.git

git clone git://github.com/Xilinx/linux-xlnx.git

Download patches

http://www.trenz-electronic.de/fileadmin/docs/Trenz_Electronic/TE0720-GigaZee/reference_designs/TE0720-

Unzip and copy files

unzip TE0720-01_linux-xlnx.zip

cp linux-xlnx_TE0720.patch linux-xlnx

cp u-boot-xlnx_TE0720.patch u-boot.xlnx

Build linux kernel.

cd linux-xlnx

git apply linux-xlnx_TE0720.patch

make ARCH=arm TE0720_defconfig

make ARCH=arm LOADADDR=0x8000 ulmage

make ARCH=arm TE0720-01-xxF.dtb



make ARCH=arm TE0720-01-xxR.dtb

Build U-Boot

git apply u-boot-xlnx_TE0720.patch

make zynq_TE0720_config

make



High speed ADC Interfacing

TE0720 has no length matching between differential pairs from the FPGA fabric to B2B Connectors. Trace lengths are available in download area, and could be used together with Xilinx provided FPGA Package delay timings to adjust system trace delays.

Zynq 7020-CLG484 largest package delay difference within one bank is 37 mm (B13 L4 to L22). Such large trace differences can not be matched on the module.

For most high speed input designs this delay matching is not needed, as long as the total delay differences are not too large. The delays can be matched using IDELAYE2 primitive on each signal line that needs to be matched. The delays can be set fixed or can be adjustable. Possible use could have the data line delays fixed, and clock/strobe delay variable.

With 300MHz calibrate clock the PCB trace lengths can be matched to be +-4 mm from the mid delay of the group.

References

UG471

XAPP524

XAPP524 does not have IDELAY on data lanes!



Petalinux

Based on Petalinux 2014.2 release, Kernel 3.14.2

FSBL

Xilinx standard FSBL is used, only fsbl_hooks.c is customized to perform all needed pre-initialization code.

FSBL bsp files are not auto updated with petalinux-config --get-hw-description so please if you change the system in Vivado and import HDF and if there are changes that are relevant to FSBL please copy over the ps7_init.c and ps7_init.h files into the FSBL build folder manually.

MAC Address handling

MAC Address is read out from EEPROM and set correctly to the PS7 ETH IP Core in order to use and keep this MAC address the following boot process should not attempt to set it again. For this the MAC address is set to empty string in the petalinux configuration. This causes a warning "can not set MAC Address during boot process - this is not an error, MAC address is set correctly and can be seen in linux using ifconfig. Notice that in u-boot it looks like MAC address is not set, as the u-boot variable is not set.



Debug


Booting U-Boot via JTAG

Booting U-Boot via JTAG

Step 1: download files ps7_init.tcl and u-boot.elf from download area

Step 2: connect JTAG Cable

Step 3: connect logic level UART adapter RX to MIO15 (PS UART0 TX) and TX to MIO14 (PS UART0 RX) connection example for TE0603

Step 4: open serial port terminal, setting 115200, 8N1

Step 5: start Xilinx XMD - use Xilinx SDK menu, Xilinx Tools> XMD Console or start XMD from commandline

Step 6: make sure files **ps7_init.tcl** and **u-boot.elf** are "in current folder" as seen by XMD (use pwd to check where current dir points and cd to change directory if needed)

Step 7: type *connect arm hw*<CR>

Step 7: type *source ps7_init.tcl*<CR>

Step 8: type *ps7_init*<CR>

Step 9: type dow u-boot.elf<CR>

Step 10: type con<CR>

At this point u-boot (loaded over JTAG) should be running and prompt should appear in serial console - please press some key in the console window, or u-boot may continue to load linux!

If TE0720 has valid boot images either in SPI Flash or on SD card, it is necessary to prevent linux from loading, either remove SD card, or in case SPI boot, press any key when u-boot loaded from SPI flash is waiting for user input. Should linux start, then it may not be possible to connect to ARM core from XMD.

Old instructions

Build base hardware project using instructions from Base PlanAhead Project or Base XPS Project

Build FSBL by instructions from FSBL - First Stage Boot Loader

In SDK open main.c file and add infinite loop instruction after system initialization. This loop required to stop normal boot sequence.





Select Run->Run As -> Launch on Hardware

C	•		
	(no launch history)		
	Run As	3	1 Launch on Hardware
	Run Configurations	C	2 Local C/C++ Application
	Organize Favorites	3	3 Remote ARM Linux Application

Open XMD Console

Xilin	x Tools Window Help										
5	Generate linker script										
11	Board Support Package Settings										
0	Repositories										
*	Program FPGA										
7	Program Flash										
	Launch Hardware Server										
X	XMD Console										
>	Launch Shell										
	Configure JTAG Settings										
8	System Generator Co-Debug Settings										
	Create Zynq Boot Image										

In XMD console type

stop connect arm hw

After this commands system will be initialized and ready to load programms and data to DDR memory.



```
🖹 Problems 🖉 Tasks 🗐 Console 🔲 Properties 🖉 Terminal 🔯 XMD Console 🛛
XMD Process
Download Progress.10.20.30.40.50.60.70.80.90.Done
Setting PC with Program Start Address 0x00000000
RUNNING> stop
Processor stopped
XMD%
XMD% connect arm hw
    _____
Enabling extended memory access checks for Zynq.
Writes to reserved memory are not permitted and reads return 0.
To disable this feature, run "debugconfig -memory access_check disable".
   _____
                         _____
CortexA9 Processor Configuration
 _____
Version.....0x00000003
User ID.....0x00000000
No of PC Breakpoints......6
No of Addr/Data Watchpoints.....4
Connected to "arm" target. id = 64
Starting GDB server for "arm" target (id = 64) at TCP port no 1235
XMD%
```

Optionally, binary data can be downloaded to memory. This data can be used in u-boot to initialize SPI Flash.

dow -data FILENAME.BIN 0x100000

where 0x100000 is location in DDR memory where binary file FILENAME.BIN would be loaded



```
🖹 Problems 🖉 Tasks 🗐 Console 🔲 Properties 🖉 Terminal 🔯 XMD Console 😒
XMD Process
JTAG chain configuration
_____
Device ID Code IR Length Part Name
1 4ba00477 4 Cortex-A9
                 4 Cortex-A9
2
     23727093
                    6
                          XC7Z020
  _____
Enabling extended memory access checks for Zynq.
Writes to reserved memory are not permitted and reads return 0.
To disable this feature, run "debugconfig -memory_access_check disable".
  _____
CortexA9 Processor Configuration
_____
Version.....0x00000003
User ID.....0x00000000
No of PC Breakpoints......6
No of Addr/Data Watchpoints.....4
Connected to "arm" target. id = 64
Starting GDB server for "arm" target (id = 64) at TCP port no 1240
XMD% dow -data b:\\boot.bin 0x1000000
Downloading Data File -- b:\boot.bin at 0x01000000
Progress .....
XMD&
•
                                          111
XMD%
```

Download u-boot.elf file

dow b:\u-boot.elf

where b:\ should be replaced with actual path to u-boot.elf file



🖹 Problems 🖉 Tasks 🗐 Console 🔲 Properties 🖉 Terminal 🙀 XMD Console 🛛 XMD Process No of Addr/Data Watchpoints 4 Connected to "arm" target. id = 64 Starting GDB server for "arm" target (id = 64) at TCP port no 1235 XMD% dow b:\u-boot.elf warning: Data caches are enabled in the system control register. This could reduce the download speed and if the processor is in unknown state, it could lead to interrupt failures, etc. Please run "rst [-processor]" command before dow, to overcome this issue Processor started. Type "stop" to stop processor User Interrupt, Processor Stopped at 0x000036e0 Downloading Program -- b:u-boot.elf section, .text: 0x04000000-0x0402d73f section, .rodata: 0x0402d740-0x04039395 section, .hash: 0x04039398-0x040393ef section, .ARM.extab: 0x040393f0-0x04039407 section, .ARM.exidx: 0x04039408-0x0403942f section, .data: 0x04039430-0x0403b4d3 section, .got.plt: 0x0403b4d4-0x0403b4df section, .u_boot_list: 0x0403b4e0-0x0403bb83 section, .rel.dyn: 0x0403bb84-0x04041e93 section, .dynsym: 0x04041e94-0x04041fa3 section, .bss: 0x0403bb84-0x0407b3bb Download Progress..10.20.30.40.50.60.70.80.90.Done Setting PC with Program Start Address 0x04000000 XMD% -XMD%

run



```
🖹 Problems 🖉 Tasks 🗐 Console 🔲 Properties 🖉 Terminal 🔯 XMD Console 😒
XMD Process
Version.....0x00000003
User ID.....0x00000000
No of PC Breakpoints......6
No of Addr/Data Watchpoints ..... 4
Connected to "arm" target. id = 64
Starting GDB server for "arm" target (id = 64) at TCP port no 1237
XMD% dow b:\u-boot.elf
Downloading Program -- b:u-boot.elf
    section, .text: 0x04000000-0x0402d73f
    section, .rodata: 0x0402d740-0x04039395
    section, .hash: 0x04039398-0x040393ef
    section, .ARM.extab: 0x040393f0-0x04039407
    section, .ARM.exidx: 0x04039408-0x0403942f
    section, .data: 0x04039430-0x0403b4d3
    section, .got.plt: 0x0403b4d4-0x0403b4df
    section, .u boot list: 0x0403b4e0-0x0403bb83
    section, .rel.dyn: 0x0403bb84-0x04041e93
    section, .dynsym: 0x04041e94-0x04041fa3
    section, .bss: 0x0403bb84-0x0407b3bb
Download Progress..10.20.30.40.50.60.70.80.90.Done
Setting PC with Program Start Address 0x04000000
XMD% run
RUNNING> 0
XMD%
 -
XMD%
```

This command runs U-Boot from DDR memory.



ARM DS-5

ARM offers a free and paid version of their development studio DS-5. The free version can be used for Linux application debug using gdbserver over Ethernet.

All PDF guides and other information at ARM and Xilinx websites about the use of DS-5 with Zynq appear to be out-dated. The screen-shots looks different, the instructions do not match, etc.

It is is possible to setup everything manually, but it takes time, and some steps need to be done manually each time the TE0720 is powered on. Basically you need to fix the IP addresses so that the TE0720 is visible and accessible from your PC host. Next you need to make sure gdbserver pre built executable is on the TE0720 file system and accessible (in newer builds it is included).

Debug Configurations		×
Create, manage, and run configuratio		Ť.
Image: Second Secon	ame: TE0720 Hello.C from Eclipse Connection Files * Debugger * OS Awareness + Arguments E Environment Select target Select target Generic / gdbserver / Linux Application Debug / Download and debug application Filter platforms Android Generic Gene	pplication.
Filter matched 21 of 21 items	Apply	Kevert
?	Debug	Close

Select "Download and debug application", and RSE connection previously configured.



Debug Configurations	×
Create, manage, and run configuration Create, edit or choose a configuration to la	aunch a DS-5 debugging session.
Image: Second Secon	Name: TE0720 Hello.C from Eclipse
Filter matched 21 of 21 items	Apply Reyert
?	Debug Close Close

Very important, you must select /hello/stripped/hello as application to download and /hello/hello to load symbols from. If you forget the "stripped" then you get error launching gdbserver!



DS-5 Debug - Eclipse Platform												
<u>File Edit Navigate Search Projec</u>	Eile Edit Navigate Search Project Run Window Help											
	<i>∦</i> ▼ 2 × 2 × 4 ↔ • ↔ •			🖹 🖬 🏕								
🏘 D 🕱 📲 R 🧏 🗖 🗖	🗖 Commands 🛛 🗖 History 🦓 Scripts	🖉 Terminals) 📓 🛼 🚮 爹 🔻 🌞 🖤 🖶	🗆 🕪= Varia 🤷 Break 💷 Re	gis 🕱 🖓 Expre f() Func 🛛 🗖 🗖								
~	🛓 Lini	ked: TE0720 -										
	Connected to stopped target gdbserv	er at 192.168.140.69 port 5000		Linked: TE0720 -								
	Execution stopped at: 0xB6FD7D60	[0vP6ED7DEC] _ 0v27204	Name	Value Size Access								
咚 ▾ 않 ▾	cd "C:\daten\shared\ds5ws"	, [0,0010/010] = 0,2/204	🖶 🗁 Core									
	Working directory "C:\daten\shared\	ds5ws"	- 🖌 R0	0x00000000 32 R/W								
TE0720 connected			- 🛛 R1	ØxBEFFFEBB 32 R/W								
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Thread 810 #1 stoppe			- • R3	0x00000000 32 R/W								
= 0xB6FD7D60			- • R4	0x00000000 32 R/W								
🗁 All Threads				0x00000000 32 K/W								
				0x00000000 32 R/W								
				0x00000000 32 R/W								
			- • R9	0x00000000 32 R/W								
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TE0720 connected	Command: Press (Ctrl+Space) for Content As	sist	Dit NEON Quad Barra									
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	11	bisassembly 🕴 🗄 Memory 🚪 Modules	Events 🗄 Outline	A								
			🔄 Linked: TE0720 🔻									
	1	🏠 🗇 🖒 🚦 👻 <next instruction=""></next>	100									
		Address Opcode Disassembly										
	•	0xB6FD7D60 259FA094 LDR r10, [p	<pre>dc,#148]; [0xB6FD7DFC] = (#148]; [0xB6FD7DFC] = (#148]; [0xB6FD7DFC]</pre>	x27204								
		0xB6FD7D64 E59F4094 LDR F4, [pc 0xB6FD7D68 E1A0000D MOV r0, sp	,#148];[0x86FD/200] = 0	(944								
		0xB6FD7D6C EB0010F7 BL {pc}+0	x43e4 ; 0xb6fdc150	-								
		App Console 🛛 🗖 Target Console 🥺 E	rror Log 🖳 Console									
			Linked: TE0720 -									
			v	A								
	#	cd "/bin"										
	#	export LD_LIBRARY_PATH=".:/bin:\$LD_I	LIBRARY_PATH"									
	# P	rocess /bin/cli server created: nid :	= 810	-								
₽												

ARM DS-5 debugger view with active gdbserver connection to TE0720 on TE0701 carrier. TE0720 default firmware, gdbserver executable from ARM DS-5 distribution, no custom software needed to make the debugger connection.



DS-5 Debug - C:\daten\shared\ds5ws\srd	c\hello.c - Eclipse Platform				Bella.c							- 🗆 🗙
<u>File Edit Source Refactor Navigate</u>	Se <u>a</u> rch <u>P</u> roject <u>R</u> un <u>W</u> indo	w I	<u>H</u> elp									
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🏶 D 🕒 P 📲 R 🛛 🔂 S 👘 🗖	🗖 Commands 🗖 History 💐	Scr	ipts 🎜 Terminals 🛛	- 0	🕪= Variables 🛛 💊 Bre	akpoints 🔤 Reg	gisters	Express	ions f() Fu	nctions		A 🗸 🗖 🗖
	🖅 TE0701 😒				🚖 Linked: TE0720 🗸							
📑 Local	zynq>			^	Name	Value	Туре	Count Size	e Location	Access		
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Local Shells						0xB6EAC000	char**	1 30	0vBEFFFC70	R/W		
					i ⊕ @ [0]	0x00145F18	char*	1 32	0xB6FAC000	R/W		
My Home					- • [0]	Unavailable	char	8	3 0x00145F18	R/W		
* Root					🖙 🗁 File Statics (current)	0 of 1 files						
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hello.c 🛿	- 8	183	Disassembly 🛛 🗏 Me	mory 🗧	Modules 🔚 Events 🗄 Ou	utline						A
1#include <stdio.h></stdio.h>	*					🔄 🔄 Linked: TE07	720 -					
2 3 int main(int argc, char *argy	(1)	6	🏠 🗇 🖒 🚦 🔻 🛛 Next Ins	truction>			10	00				
⇒ 4 {			Address Opcode	Disasser	nbly							
<pre>5 printf("Hello world!\n"); 6 potump 0;</pre>			0x00008424 000105A0	DCD	0x000105A0							•
7}			0x00008428 00000000)CD main	0×00000000							
8			0x0000842C	PUSH	{r11,lr}							
9			0x00008430 E28DB004	ADD	r11,sp,#4							
			0x00008438 E5080008	506 5TR	r0,[r11,#-8]							
			0x0000843C E508100C	STR	r1,[r11,#-0xc]							
			0x00008440 E59F0010	LDR	r0,[pc,#16]; [0x8458	3] = 0x8534						
			0x00008448 E3A03000	NOV	r3,#0	9996						
						~						*
			App Console 🛛 🗖 Ta	rget Cons	ole 🕙 Error Log 🖳 Consol	le					B. B.	. 🚮 🗸 🗖 🗖
						🔄 Linked: TE07	720 🕶					
		Pr	reparing the debug ses	sion								*
		#	cd "/bin"									
		#	export LD_LIBRARY_PAT	H=".:/b:	in:\$LD_LIBRARY_PATH"							
		# P	gdbserver :5000 "/bin rocess /bin/bello crea	/hello" ted: nic	= 724							E
		Li	istening on port 5000	ccoj pri								
4		De	ebug session has been	started	, connecting to gdbserv	ver						
	P	Re	emote debugging from n	OSC 192	.100.140.39				1			•
4 D*												

Debug session with symbols loaded and ssh console opened to the target.





Simple modified Helloworld example. This time compiled within DS-5 on a Windows machine and downloaded and executed on a TE0720.

Streamline

DS-5 Debug - C:\daten\shared\Capture_C01_A01.ap	d - Eclipse Platform		
<u>File Edit Navigate Search Project Run Winde</u>	ow <u>H</u> elp		
	Image: Image		EP 40 🕸
🏘 Deb 陷 Proj 📕 Re 🛛 Stre 🛛 📃	🗖 Commands 🗖 History 🤻 Scripts 🖉 Terminals 🛛	- 8	🕬= Variable 🛛 💁 Breakp 🔤 Register 🦥 Expressi f() Functio 👘 🗖
0 🗶 🚸 🛤	∆ TE0720 😒		▽
103 168 140 100	7///// Uname -a	^	Linked: hello-FVP-example ▼
Capture_C01 27.08.2031011/9 gator V14 (D5-5 v5.15) 23.08.140.199 Xilin: Zynq Platform Cidaten Ishared	2)ndy uname -0 Linux 192.168.42.50 3.8.0-xilinx-00021-g221c0f4-dirty # 8:21:24 PDT 2013 armv71 GNU/Linux zynqy zynqy zynqy	L SMP PREEMPT Sun	Variable information is not available.
Capture (01, A01 9699 @ 2708 2013 101122: 152108 40199 - Ximix 2)nq Platform Cidatentabared	zynq>		
A hello.c Apture C01 A01	- C	111 Disassembly	비 Memory) 를 Modules) 문 Events) 문 Outline V 미 미
Timeline & Functions Re Professional Edition F	eatures		Linked: hello-FVP-example ▼
	Tilter pro	Disassembly information	on is not available.
522 545 565 585 66 6 Linux Scheduler ► 100%	21 6.41 6.65 6.51 72 7.21 7.41 7.45		
Clock ISO MHz	© 16.06 MHz avg		
Disk IO	0 B		
O Read	0 B		
Instruction		App Console 25	Linkert hello-EV/P-example *
Executed 🌣	376376	Preparing the del	bug session
	~~~	# cd "/tmp"	
Memory 150 MB	90,64 MB avg.	# export LD_LIBR	ARY_PATH=".:\$LD_LIBRARY_PATH"
Used	35,38 MB avg.	# gdbserver :5000 Process ./hello 0	0 "./hello" Demo Test created; pid = 785
		Listening on port	t 5000
[idie]		Remote debugging	from host 192.168.140.59
[vernel]     [gatord #764]		Killing all infer #	riors

Streamline profiling on TE0720 - a simple screen of activity.

when using proper build all that is needed is to add init.sh to SD card

#!/bin/sh
ifconfig eth0 192.168.140.199
insmod /root/gator.ko
/bin/gatord &

Example init.sh to set fixed IP address and start gator



## Compile/Install

Instructions for 64-bit Windows (i.e. always download 64-bit packages):

- 1. Install Cygwin from: http://cygwin.com/install.html
  - a. In the step "Cygwin Setup Select packages", select collection "Devel" and click on the word "Default" to change the installation type to "Install":

Search 🗌		Qear		C Keep	(F. Gur	C E	бар Улем	Category
Calegory	New		Bn7	Src7	Size		Package	
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	01.116-1			Ē		81k	automake1.1	1:(1.11) at
4					000			E.

- b. Cygwin requests installation of additional packages to resolve dependencies in this step, click "Next".
- c. Get a cup of tea of coffee as it takes a while to download all required packages.
- 2. On the start menu, click "Cygwin64 Terminal".

E-	
Andrei#AnduAX -	~
\$	
	-

- a. The cygwin terminal opens:
- b. A home directory in the Cygwin installation is created automatically. The home directory can be found in the directory "C:\cygwin64\home\USERNAME" where "USERNAME" is your Windows username.
- c. Minimize the cygwin terminal to the taskbar.
- 3. Get the latest OpenOCD ZIP archive from: http://sourceforge.net/projects/openocd/files/openocd/ .
  - a. Copy the contents to your home directory in the Cygwin installation.
    - b. Thus, the OpenOCD sources should be in the directory
       "C:\cygwin64\home\USERNAME\openocd-0.7.0", where USERNAME is your Windows username and OpenOCD version is "0.7.0".
- 4. Get the latest FTDI D2XX drivers as a ZIP archive from http://www.ftdichip.com/Drivers/D2XX.htm .
  - a. Copy the contents to your home directory in the Cygwin installation.
  - b. Rename the long directory name "CDM v2.08.28 Certified" to "ftd2xx".
  - c. Plug the FTDI JTAG dongle (TODO: is dongle name correct?) and install the drivers from this directory unless you have the drivers installed already.



5. Click here to download the zynq patch (origin:

http://sourceforge.net/mailarchive/forum.php?thread_name=20130403122006.003E12432C%40openc) and save it in your home directory in the Cygwin installation.

6. Activate the cygwin terminal and verify that your home directory contains both directories, "ftd2xx" and "openocd-0.7.0" and the patch file "zynq.patch" by running command "ls":



- 7. Change the working directory to "openocd-0.7.0" by running the command "cd openocd-0.7.0".
- 8. Apply the zynq patch by running the command "patch -p1 < ../zynq.patch".
- Run the configuration script with a following command: ./configure --enable-maintainer-mode --disable-werror --disable-shared --enable-ft2232_ftd2xx --build=i686-pc-linux-gnu --host=i686-w64-mingw32 --with-ftd2xx-win32-zipdir=\$HOME/ftd2xx This will generate Makefile-s needed for the compilation of OpenOCD.
- 10. Compile OpenOCD with the command "make". This takes a few minutes.
- 11. Minimize the cygwin terminal
- Executable "openocd.exe" can be found in the directory "C:\Cygwin64\home\USERNAME\openocd-0.7.0\src", where USERNAME is your Windows username.

Shorter alternative to steps 3... 11:

- 1. Click here to get the mkopenocd.sh skript and save it in your home directory in the Cygwin installation.
- 2. Activate the cygwin terminal and run the following commands:
  - a. chmod +x mkopenocd.sh
  - b. ./mkopenocd.sh

```
> halt
```

number of cache level 1

ZYNQ_PS.cpu cluster 0 core 0 multi core

target state: halted

target halted in ARM state due to debug-request, current mode: System

cpsr: 0x6000015f pc: 0x0001df18

MMU: disabled, D-Cache: disabled, I-Cache: disabled

> mdw 0 4



0x00000000: ea000023 ea00000d ea000010 ea00001c

>

Example session with openood, target platform 7020 (non ES silicon) on TE0720 using TE0701 on board JTAG circuitry.

interface ft2232 ft2232_layout "digilent-hs1" ft2232_latency 2 ft2232_device_desc "Digilent USB Device" ft2232_vid_pid 0x0403 0x6010

adapter_khz 10000 set_CHIPNAMEZYNQ_PS set_TARGETNAME \$_CHIPNAME.cpu

jtag newtap ZYNQ_PL bs -irlen 6 -ircapture 0x1 -irmask 0x03 -expected-id 0x23727093 jtag newtap \$_CHIPNAME dap -irlen 4 -ircapture 0x1 -irmask 0xf -expected-id 0x4ba00477 target create \$_TARGETNAME cortex_a8 -chain-position \$_CHIPNAME.dap -coreid 0 \$_TARGETNAME configure -work-area-phys 0x0 -work-area-size 0x1000

Example config for openocd, the above does not support SRST ARM reset signal, openocd patch is available to support reset assertion.

Name	Version	Date
image2013-7-26 21:54:20.png	1	2013-07-26 19:54
image2013-7-26 21:54:57.png	1	2013-07-26 19:54
image2013-7-26 21:55:30.png	1	2013-07-26 19:55
image2013-7-26 21:55:58.png	1	2013-07-26 19:55
image2013-7-26 21:56:23.png	1	2013-07-26 19:56
image2013-7-26 21:57:25.png	1	2013-07-26 19:57
image2013-7-26 22:0:7.png	1	2013-07-26 19:59
image2013-7-26 22:12:14.png	1	2013-07-26 20:12
image2013-7-26 22:12:46.png	1	2013-07-26 20:12
image2013-7-26 22:13:21.png	1	2013-07-26 20:13
image2013-7-26 22:13:36.png	1	2013-07-26 20:13
image2013-7-26 22:14:52.png	1	2013-07-26 20:14
image2013-7-26 22:28:12.png	1	2013-07-26 20:28
image2013-7-26 22:3:46.png	1	2013-07-26 20:03
image2013-7-28 10:39:37.png	1	2013-07-28 08:39



Name	Version	Date
image2013-7-28 10:5:6.png	1	2013-07-28 08:05
image2013-7-28 10:6:22.png	1	2013-07-28 08:06
image2013-7-28 9:38:36.png	1	2013-07-28 07:38
mkopenocd.sh	1	2013-07-28 22:27
zynq.patch	1	2013-07-28 21:40



### **DCC Console**

DCC Console allows uart console style debugging over ARM JTAG.

There are no bare-metal examples but Xilinx u-boot repository can be checked for the DCC console driver implementation. For experiments there are pre-compiled u-boot-dcc images within Xilinx SDK installation (location depends on the version of installed Xilinx tools).

#### Xilinx precompiled OCM RAM u-boot images

C:\Xilinx\Vivado\2014.2\data\xicom\cfgmem\uboot

06/10/2014 08:35 PM 582,145 nand_16.bin 06/10/2014 08:34 PM 581,977 nand_8.bin 06/10/2014 08:34 PM 419,444 nor.bin 06/10/2014 08:34 PM 472,007 qspi_dual_parallel.bin 06/10/2014 08:34 PM 472,007 qspi_dual_stacked.bin 06/10/2014 08:35 PM 472,271 qspi_single.bin

The above images are compiled version of u-boot from Xilinx git repository. They are just renamed from BIN to ELF. It is possible to execute them on TE0720 as well from SDK debugger. The one of interest is sqpi_single it allows u-boot to access QSPI flash on TE0720.

The only requirement is that OCM RAM blocks must be remapped to high memory, this is where the u-boot object is loaded.

Write 0x0000000F to OCM_CFG register (at 0xF8000910) before loading the uboot image into OCM RAM. When executed the u-boot will send console over ARM DCC channel to Xilinx debugger terminal.





# Handling and usage precautions

#### General

- Unpack and handle the module in an ESD safe workplace only.
- Keep the module away from moisture and dust.
- Remove power completely before plugging the module onto or unplugging it from a carrier board.
- Do not apply any voltage to any pin, when the module is not powered.
- Do not apply any voltage to any I/O pin, when the Power Good signal of the module is not active.

#### **Removal Instructions**

Samtec LSHM connectors are shock-proof and vibrations resistant, and have therefore high mating forces. It is recommended to remove the module via the mounting holes. When mounted with distance holders, unscrew the screws on the baseboard bottom about 2 mm, then press the baseboard equally (e.g. on a desktop) to lift the module. Repeat this until the module is unplugged [see Video below]. If this is not possible, you have to use a soft lever.

Important: start by pulling corners 3 and 4, then pull corners 1 and 2!



Take a soft lever, like a plastic pen, and start lifting the module at position 1 about 1 mm, then proceed with position 2.

You must lift positions 1 and 2 at least 1-1.5 mm before proceeding to lift positions 3 and 4.

Lift positions 3 and 4 a few millimeters. Repeat with positions 1 and 2 until the module is unplugged.



Failure to follow this procedure will very likely cause the left connector to break on the base board, as it is very hard to apply a controlled pull force by hand.

# Winbond 32MByte SPI Flash in 2013.4

TE0720 on-board flash can be programmed directly only with SDK Flash Programmer starting from Vivado 2013.4 version. Previous versions can not access the flash properly. Please notice that ISE/Impact 14.7 do not support Winbond 32MB, only SDK 2013.4 does!

- FSBL generated with SDK 2013.4 may not boot if some error is detected, in such cases it forces bootrom fall-back in a way that may make the Zynq device to appear as "broken"!
- A This is not related to any hardware issues, TE0720 is alive, ZYNQ is alive, and correct operation can be recovered.

## Problem description:

If SPI flash is programmed with 2013.4 version of FSBL, and if this FSBL detects some error conditions, then following happens: After POR Reset, ARM DAP TAP "disappears" from the chain. JTAG chain will look like it has only one device, that returns ZYNQ FPGA IDCODE on JTAG discovery.

JTAG Command IDCODE will return garbage. JTAG boundary scan functions are not available either. As long as this condition persists ZYNQ is completely not accessible from JTAG.

After some time (more than 10 seconds, this may however depend on the SPI flash contents) - ZYNQ bootrom gives up, and both JTAG TAPS re-appear in the JTAG Chain again. JTAG IDCODE command works now again, JTAG boundary scan is accessible, and ARM DAP is accessible as well. FPGA Configuration interface is however DISABLED, internal INIT is not released, and Impact or any other download tool can not Configure the FPGA Fabric over JTAG.



JTAG Script													0
Open Select			Run Run fi	Run Show Commands Run from File Stop On Error			Check JEDEC ID	Loa SAN	d BSDL DO MPLE EXT	NE=1 EST			
Cable	Chain	T/	AP/Debug			SVF		SPI		BSDL			
D · USB	s	VF BSDL	PDL/TCL Board/	/Module								1	
48A00477	N	lum Type	Port	F	Function	Safe	CCell	Disv	al	Rslt	Value	Direction	
····· 23727093		BC_2	*	0	controlr		1						
		BC_2	RSVDGND_G1		outputs		0						
		BC 2		10 i	input		1						
	4	BC 2	RSVD1VCC TE	B i	nput		1						
	5	BC_2	RSVD2VCC_T	- ·	nput		1						
	6	BC_2	CFGBVS_T13	i	nput		1						
Properties	7	BC_2	*	i	nternal		1						
Key Value	8	BC_2	*	c	controlr		0						
VENDOR ARM (DAP)	9	BC_2	INIT_B_T14	c	output3		0						
USERCODE n/a	1	0 BC_2	INIT_B_T14	i	nput		0						
	1	1 BC_2	*	¢	controlr		0						
	1	2 BC_2	DONE_T12	c	output3		0						
	1	.3 BC_2	DONE_T12	i	nput		0						
Devices Files	1	4 BC_2	*	i	nternal		0						-
Devices         Files         14         BC_2         * internal         0           INF0:         ToolZ         Digilent Product Name:         JTAG-ONB4         *         *         *           INF0:         ToolZ         Digilent Product ID:         \$0800157         *         *         *         *           INF0:         ToolZ         - Digilent Product ID:         \$0800157         *         *         *         *           1NF0:         ToolZ         - Vendor Product:         TE0701-03         *         *         *         *         *         *         *         *         *         *         *         *         *         *         *         *         *         *         *         *         *         *         *         *         *         *         *         *         *         *         *         *         *         *         *         *         *         *         *         *         *         *         *         *         *         *         *         *         *         *         *         *         *         *         *         *         *         *         *         *         * <td< td=""></td<>													
Messages ICL Console			48400477										

This is how BOOTROM locked device looks (after the bootrom timeout), INIT_B is set as output driving 0 from the ZYNQ device (both CONTROLR and OUTPUT3 bits are 0).

Boundary scan still works, in the screen-shot above "EF401900" is the JEDEC ID from the SPI Flash on TE0720 read using boundary scan (while ZYNQ is in bootrom locked error state).

#### **Recovery Instructions:**

On TE0701 insert SD Card, power-up, remove SD-Card, press Reset button, then reprogram Flash with known good image using SDK 2013.4 Flash Programmer.

If only available boot mode is SPI Flash boot then after the bootrom timeout (when 2 devices are back in JTAG chain) SDK Flash Programmer can reprogram the Flash.



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## **Technology Licenses**

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#### **Environmental protection**

To confront directly with the responsibility toward the environment, the global community and eventually also oneself. Such a resolution should be integral part not only of everybody's life. Also enterprises shall be conscious of their social responsibility and contribute to the preservation of our common living space. That is why Trenz Electronic invests in the protection of our Environment.



# REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals) compliance statement

Trenz Electronic is a manufacturer and a distributor of electronic products. It is therefore a so called downstream user in the sense of REACH. The products we supply to you are solely non-chemical products (goods). Moreover and under normal and reasonably foreseeable circumstances of application, the goods supplied to you shall not release any substance. For that, Trenz Electronic is obliged to neither register nor to provide safety data sheet.

According to present knowledge and to best of our knowledge, no SVHC (Substances of Very High Concern) on the Candidate List are contained in our products.

Furthermore, we will immediately and unsolicited inform our customers in compliance with REACH - Article 33 if any substance present in our goods (above a concentration of 0,1 % weight by weight) will be classified as SVHC by the European Chemicals Agency (ECHA).

#### **RoHS (Restriction of Hazardous Substances) compliance statement**

Trenz Electronic GmbH herewith declares that all its products are developed, manufactured and distributed RoHS compliant.

#### WEEE (Waste Electrical and Electronic Equipment)

Information for users within the European Union in accordance with Directive 2002/96/EC of the European Parliament and of the Council of 27 January 2003 on waste electrical and electronic equipment (WEEE).

Users of electrical and electronic equipment in private households are required not to dispose of waste electrical and electronic equipment as unsorted municipal waste and to collect such waste electrical and electronic equipment separately. By the 13 August 2005, Member States shall have ensured that systems are set up allowing final holders and distributors to return waste electrical and electronic equipment at least free of charge. Member States shall ensure the availability and accessibility of the necessary collection facilities. Separate collection is the precondition to ensure specific treatment and recycling of waste electrical and electronic equipment and is necessary to achieve the chosen level of protection of human health and the environment in the European Union. Consumers have to actively contribute to the success of such collection and the return of waste electrical and electronic equipment.

Presence of hazardous substances in electrical and electronic equipment results in potential effects on the environment and human health. The symbol consisting of the crossed-out wheeled bin indicates separate collection for waste electrical and electronic equipment.

Trenz Electronic is registered under WEEE-Reg.-Nr. DE97922676.