TE0813 Test Board

Revision v.5

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Online version of this document:

https://wiki.trenz-electronic.de/display/PD/TE0813+Test+Board

1 Table of Contents

2 Table of Figures

3 Table of Tables

4 Overview

Design Example with minimum PS Setup (DDR, QSPI, UART0) only for custom boards or easier debug via Vitis.

Refer to http://trenz.org/te0813-info for the current online version of this manual and other available documentation.

4.1 Key Features

- Vitis/Vivado 2020.2
- QSPI
- Custom Carrier (minimum PS Design with available module components only)
- Modified FSBL (some additional outputs only)
- Special FSBL for QSPI Programming

4.2 Revision History

Date	Vivado	Project Built	Authors	Description
2021-11-16	2020.2	TE0813-test_board_noprebuilt-vivado_2020.2-build_9_20211116073725.zip TE0813-test_board-vivado_2020.2-build_9_20211116073013.zip	John Hartfiel	• new variants
2021-10-28	2020.2	TE0813-test_board-vivado_2020.2-build_8_20211028144436.zip TE0813-test_board_noprebuilt-vivado_2020.2-build_8_20211028144418.zip	Manuela Strücker	• initial release

Table 1: Design Revision History

4.3 Release Notes and Know Issues

Issues	Description	Workaround	To be fixed version
Xilinx Software	Incompatibility of board files for ZynqMP with eMMC activated between 2021.2 and 2021.2.1 patch, see Xilinx Forum Request[1]	use corresponding board files for the Vivado versions	--

1 https://support.xilinx.com/s/feed/0D54U00005Wbon6SAB?language=en_US

Issues	Description	Workaround	To be fixed version
QSPI Flash	Programming QSPI flash fails sometimes	use Vivado 2019.2 for programming	

Table 2: Known Issues

4.4 Requirements

4.4.1 Software

Software	Version	Note
Vitis	2020.2	needed, Vivado is included into Vitis installation

Table 3: Software

4.4.2 Hardware

Basic description of TE Board Part Files is available on TE Board Part Files.[2]

Complete List is available on "<project folder>\board_files*_board_files.csv"

Design supports following modules:

Module Model	Board Part Short Name	PCB Revision Support	DDR	QSPI Flash	EMMC	Others	Notes
TE0813-01-4BE11-A*	4eg_2gb	REV01	2GB	128MB	NA	NA	NA
TE0813-01-2AE11-A	2cg_2gb	REV01	2GB	128MB	NA	NA	NA
TE0813-01-2BE11-A	2eg_2gb	REV01	2GB	128MB	NA	NA	NA

2 https://wiki.trenz-electronic.de/display/PD/TE+Board+Part+Files

Module Model	Board Part Short Name	PCB Revision Support	DDR	QSPI Flash	EMMC	Others	Notes
TE0813-01-3AE11-A	3cg_2gb	REV01	2GB	128MB	NA	NA	NA
TE0813-01-4AE11-A	4cg_2gb	REV01	2GB	128MB	NA	NA	NA
TE0813-01-5DE11-A	5ev_2gb	REV01	2GB	128MB	NA	NA	NA
TE0813-01-3BE11-A	3eg_2gb	REV01	2GB	128MB	NA	NA	NA
TE0813-01-4DE11-A	4ev_2gb	REV01	2GB	128MB	NA	NA	NA

Table 4: Hardware Modules
*used as reference

Note: Design contains also Board Part Files for TE0813+TEBF0818 configuration, this board part files are not used for this reference design.

Design supports following carriers:

Carrier Model	Notes
TEBF0818*	Used as reference carrier.

Table 5: Hardware Carrier
*used as reference

Additional HW Requirements:

Additional Hardware	Notes
---	---

Table 6: Additional Hardware
*used as reference

4.5 Content

For general structure and usage of the reference design, see Project Delivery - Xilinx devices[3]

4.5.1 Design Sources

Type	Location	Notes
Vivado	<project folder>\block_design <project folder>\constraints <project folder>\ip_lib <project folder>\board_files	Vivado Project will be generated by TE Scripts
Vitis	<project folder>\sw_lib	Additional Software Template for Vitis and apps_list.csv with settings automatically for Vitis app generation

Table 7: Design sources

4.5.2 Additional Sources

Type	Location	Notes
---	---	---

Table 8: Additional design sources

4.5.3 Prebuilt

File	File-Extension	Description
BIF-File	*.bif	File with description to generate Bin-File

3 https://wiki.trenz-electronic.de/display/PD/Project+Delivery+-+Xilinx+devices

File	File-Extension	Description
BIN-File	*.bin	Flash Configuration File with Boot-Image (Zynq-FPGAs)
BIT-File	*.bit	FPGA (PL Part) Configuration File
Diverse Reports	---	Report files in different formats
Hardware-Platform -Description-File	*.xsa	Exported Vivado hardware description file for Vitis and PetaLinux
LabTools Project-File	*.lpr	Vivado Labtools Project File
Software-Application-File	*.elf	Software Application for Zynq or MicroBlaze Processor Systems

Table 9: Prebuilt files (only on ZIP with prebult content)

4.5.4 Download

Reference Design is only usable with the specified Vivado/Vitis/PetaLinux version. Do never use different Versions of Xilinx Software for the same Project.

Reference Design is available on:

- TE0813 "Test Board" Reference Design[4]

4 https://shop.trenz-electronic.de/Download/?path=Trenz_Electronic/Modules_and_Module_Carriers/5.2x7.6/TE0813/Reference_Design/2020.2/test_board

5 Design Flow

> Reference Design is available with and without prebuilt files. It's recommended to use TE prebuilt files for first launch.

Trenz Electronic provides a tcl based built environment based on Xilinx Design Flow.

See also:

- Xilinx Development Tools[5]
- Vivado Projects - TE Reference Design[6]
- Project Delivery.[7]

The Trenz Electronic FPGA Reference Designs are TCL-script based project. Command files for execution will be generated with "_create_win_setup.cmd" on Windows OS and "_create_linux_setup.sh" on Linux OS.

TE Scripts are only needed to generate the vivado project, all other additional steps are optional and can also executed by Xilinx Vivado/Vitis GUI. For currently Scripts limitations on Win and Linux OS see: Project Delivery Currently limitations of functionality[8]

> **Caution!** Win OS has a 260 character limit for path lengths which can affect the Vivado tools. To avoid this issue, use Virtual Drive or the shortest possible names and directory locations for the reference design (for example "x:\<project folder>")

1. Run _create_win_setup.cmd/_create_linux_setup.sh and follow instructions on shell:

_create_win_setup.cmd/_create_linux_setup.sh

```
------------------------Set design paths----------------------------
-- Run Design with: _create_win_setup
-- Use Design Path: <absolute project path>
--------------------------------------------------------------------
-------------------------TE Reference Design---------------------------
--------------------------------------------------------------------
-- (0)  Module selection guide, project creation...prebuilt export...
-- (1)  Create minimum setup of CMD-Files and exit Batch
-- (2)  Create maximum setup of CMD-Files and exit Batch
-- (3)  (internal only) Dev
-- (4)  (internal only) Prod
-- (c)  Go to CMD-File Generation (Manual setup)
-- (d)  Go to Documentation (Web Documentation)
-- (g)  Install Board Files from Xilinx Board Store (beta)
-- (a)  Start design with unsupported Vivado Version (beta)
-- (x)  Exit Batch (nothing is done!)
----
Select (ex.:'0' for module selection guide):
```

2. Press 0 and enter to start "Module Selection Guide"

5 https://wiki.trenz-electronic.de/display/PD/Xilinx+Development+Tools#XilinxDevelopmentTools-XilinxSoftware-BasicUserGuides
6 https://wiki.trenz-electronic.de/display/PD/Vivado+Projects+-+TE+Reference+Design
7 https://wiki.trenz-electronic.de/display/PD/Project+Delivery+-+Xilinx+devices
8 https://wiki.trenz-electronic.de/display/PD/Project+Delivery+-+Xilinx+devices#ProjectDeliveryXilinxdevices-Currentlylimitationsoffunctionality

3. Create project and follow instructions of the product selection guide, settings file will be configured automatically during this process.
   - optional for manual changes: Select correct device and Xilinx install path on "design_basic_settings.cmd" and create Vivado project with "vivado_create_project_guimode.cmd"

   > Note: Select correct one, see also Vivado Board Part Flow[9]
   > Important: Use Board Part Files, which **did not** ends with *_tebf0818

4. Create hardware description file (.xsa file) for PetaLinux project and export to prebuilt folder

   run on Vivado TCL (Script generates design and export files into "\prebuilt\hardware\")

   ```
   \prebuilt\hardware\")">
   TE::hw_build_design -export_prebuilt
   ```

   > Using Vivado GUI is the same, except file export to prebuilt folder.

5. Generate Programming Files with Vitis

   run on Vivado TCL (Script generates applications and bootable files, which are defined in "test_board\sw_lib\apps_list.csv")

   ```
   TE::sw_run_vitis -all
   TE::sw_run_vitis (optional; Start Vitis from Vivado GUI or start with TE
   Scripts on Vivado TCL)
   ```

   > TCL scripts generate also platform project, this must be done manually in case GUI is used. See Vitis[10]

9 https://wiki.trenz-electronic.de/display/PD/Vivado+Board+Part+Flow
10 https://wiki.trenz-electronic.de/display/PD/Vitis

6 Launch

6.1 Programming

> ⚠ Check Module and Carrier TRMs for proper HW configuration before you try any design.
> Reference Design is also available with prebuilt files. It's recommended to use TE prebuilt files for first launch.

Xilinx documentation for programming and debugging: Vivado/Vitis/SDSoC-Xilinx Software Programming and Debugging[11]

6.1.1 Get prebuilt boot binaries

1. Run _create_win_setup.cmd/_create_linux_setup.sh and follow instructions on shell
2. Press 0 and enter to start "Module Selection Guide"
   a. Select assembly version
   b. Validate selection
   c. Select create and open delivery binary folder

   > ⓘ Note: Folder "<project folder>_binaries_<Article Name>" with subfolder "boot_<app name>" for different applications will be generated

6.1.2 QSPI-Boot mode

1. Connect **JTAG** and power on carrier with module
2. Open Vivado Project with "vivado_open_existing_project_guimode.cmd" or if not created, create with "vivado_create_project_guimode.cmd"

run on Vivado TCL (Script programs BOOT.bin on QSPI flash)

```
TE::pr_program_flash -swapp hello_te0813
```

> ⚠ To program with Vitis/Vivado GUI, use special FSBL (fsbl_flash) on setup

6.1.3 SD-Boot mode

This does not work, because SD controller is not selected on PS.

6.1.4 JTAG

Load configuration and Application with Vitis Debugger into device

11 https://wiki.trenz-electronic.de/display/PD/Xilinx+Development+Tools#XilinxDevelopmentTools-XilinxSoftwareProgrammingandDebugging

6.2 Usage

QSPI Boot:

1. Prepare HW like described on section Programming(see page 14)
2. Connect UART USB (most cases same as JTAG)
3. Select QSPI as Boot Mode

   Note: See TRM of the Carrier, which is used.

4. Power On PCB
   boot process

   1. ZynqMP Boot ROM loads FSBL from QSPI into OCM,

   2. FSBL init the PS, programs the PL using the bitstream and loads PMU, ATF and U-boot from QSPI into DDR,

7 System Design - Vivado

7.1 Block Design

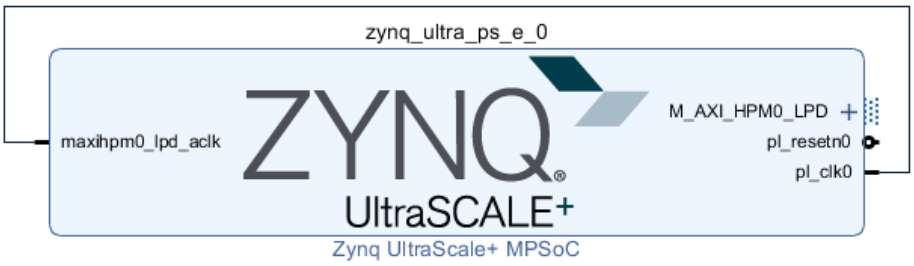

Figure 1: Block Design

7.1.1 PS Interfaces

Activated interfaces:

Type	Note
DDR	
QSPI	MIO
UART0	MIO, please select other one, if you have connected UART to second controller or other MIO
SWDT0..1	
TTC0..3	

Table 10: PS Interfaces

7.2 Constrains

7.2.1 Basic module constrains

_i_bitgen.xdc

```
set_property BITSTREAM.GENERAL.COMPRESS TRUE [current_design]
set_property BITSTREAM.CONFIG.UNUSEDPIN PULLNONE [current_design]
```

7.2.2 Design specific constrain

Not needed.

8 Software Design - Vitis

For Vitis project creation, follow instructions from:

Vitis[12]

8.1 Application

Template location: "<project folder>\sw_lib\sw_apps\"

8.1.1 zynqmp_fsbl

TE modified 2020.2 FSBL

General:

- Modified Files: xfsbl_main.c, xfsbl_hooks.h/.c, xfsbl_board.h/.c (search for 'TE Mod' on source code)
- Add Files: te_xfsbl_hooks.h/.c (for hooks and board)
- General Changes:
    - Display FSBL Banner and Device Name

8.1.2 zynqmp_fsbl_flash

TE modified 2020.2 FSBL

General:

- Modified Files: xfsbl_initialisation.c, xfsbl_hw.h, xfsbl_handoff.c, xfsbl_main.c
- General Changes:
    - Display FSBL Banner
    - Set FSBL Boot Mode to JTAG
    - Disable Memory initialisation

8.1.3 hello_te0813

Hello TE0813 is a Xilinx Hello World example as endless loop instead of one console output.

12 https://wiki.trenz-electronic.de/display/PD/Vitis

9 Additional Software

No additional software is needed.

10 Appx. A: Change History and Legal Notices

10.1 Document Change History

To get content of older revision go to "Change History" of this page and select older document revision number.

Date	Document Revision	Authors	Description
2022-09-06	v.5(see page 6)	Manuela Strücker[13]	• new Variants
2021-10-28	v.2	Manuela Strücker	• initial release 2020.2
	All	@ John Hartfiel[14], Manuela Strücker[15]	

Table 11: Document change history.
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13 https://wiki.trenz-electronic.de/display/~m.struecker
14 https://wiki.trenz-electronic.de/display/~j.hartfiel
15 https://wiki.trenz-electronic.de/display/~m.struecker

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16 http://guidance.echa.europa.eu/
17 https://echa.europa.eu/candidate-list-table
18 http://www.echa.europa.eu/

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