TE0741 Test Board

Revision v.9

Exported on 2023-12-18

Online version of this document:

https://wiki.trenz-electronic.de/pages/viewpage.action?pageId=214073409

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4 Overview

Refer to http://trenz.org/te0741-info for the current online version of this manual and other available documentation.

This example shows how to reconfigure SI5338 with the MicroBlaze_MCS and monitor the CLKs. An additional MicroBlaze is added for the Hello_TE0741 standalone application.

4.1 Key Features

- Vitis/Vivado 2021.2
- MicroBlaze
- I2C
- UART
- Flash
- FMeter
- SI5338 initialisation with MCS

4.2 Revision History

Date	Vivado	Project Built	Authors	Description
2022-06-09	2021.2	TE0741-test_board_noprebuilt-vivado_2021.2-build_14_20220609134340.zip TE0741-test_board-vivado_2021.2-build_14_20220609134340.zip	Waldemar Hanemann	• pll_in4 i2c address pin pulled to GND in System controller ip • added new variants
2022-03-15	2021.2	TE0741-test_board_noprebuilt-vivado_2021.2-build_11_20220315112318.zip TE0741-test_board-vivado_2021.2-build_11_20220315112318.zip	Waldemar Hanemann	• update 2021.2
2018-04-16	2017.4	TE0741-test_board-vivado_2017.4-build_07_20180416142	John Hartfiel	• initial release

Date	Vivado	Project Built	Authors	Description
		156.zip TE0741-test_board_noprebuilt-vivado_2017.4-build_07_20180416142217.zip		

Table 1: Design Revision History

4.3 Release Notes and Know Issues

Issues	Description	Workaround	To be fixed version
No known issues	---	---	---

Table 2: Known Issues

4.4 Requirements

4.4.1 Software

Software	Version	Note
Vitis	2021.2	needed, Vivado is included into Vitis installation
SI ClockBuilder Pro	---	optional

Table 3: Software

4.4.2 Hardware

Basic description of TE Board Part Files is available on TE Board Part Files.[1]

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

Design supports following modules:

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

Module Model	Board Part Short Name	PCB Revision Support	DDR	QSPI Flash	Others	Notes
TE0741-03-070-2IF	070_2if	REV02, REV03	---	32MB	MGT LR: 6,6 Gb/s	
TE0741-03-160-2IF	160_2if	REV02, REV03	---	32MB	MGT LR: 6,6 Gb/s	
TE0741-03-325-2IF	325_2if	REV02, REV03	---	32MB	MGT LR: 6,6 Gb/s	
TE0741-03-410-2IF	410_2if	REV02, REV03	---	32MB	MGT LR: 6,6 Gb/s	
TE0741-03-070-2CF	070_2cf	REV02, REV03	---	32MB	MGT LR: 6,6 Gb/s	
TE0741-03-160-2CF	160_2cf	REV02, REV03	---	32MB	MGT LR: 6,6 Gb/s	
TE0741-03-325-2CF*	325_2cf	REV02, REV03	---	32MB	MGT LR: 6,6 Gb/s	
TE0741-03-410-2CF	410_2cf	REV02, REV03	---	32MB	MGT LR: 6,6 Gb/s	
TE0741-03-160-2C1	160_2c1	REV02, REV03	---	32MB	MGT LR: 10,3125 Gb/s	
TE0741-02-B3E-1-AF	160_3e1	REV02, REV03	---	32MB	MGT LR: 10,3125 Gb/s	
TE0741-04-A2I-1-A	070_2if	REV04	---	32MB	MGT LR: 6,6 Gb/s	
TE0741-04-G2C-1-A	410_2cf	REV04	---	32MB	MGT LR: 6,6 Gb/s	

Module Model	Board Part Short Name	PCB Revision Support	DDR	QSPI Flash	Others	Notes
TE0741-03-S002	410_2cf	REV03	---	32MB	MGT LR: 6,6 Gb/s	

Table 4: Hardware Modules
*used as reference

Design supports following carriers:

Carrier Model	Notes
TE0701	
TE0703*	
TE0705	
TE0706	

Table 5: Hardware Carrier
*used as reference

Additional HW Requirements:

Additional Hardware	Notes
USB Cable for JTAG/UART	Check Carrier Board and Programmer for correct type
XMOD Programmer	Carrier Board dependent, only if carrier has no own FTDI

Table 6: Additional Hardware
*used as reference

4.5 Content

For general structure and usage of the reference design, see Project Delivery - AMD devices[2]

2 https://wiki.trenz-electronic.de/display/PD/Project+Delivery+-+AMD+devices

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
SI5338	<project folder>\misc\Si5338	SI5338 Project with current PLL Configuration

Table 8: Additional design sources

4.5.3 Prebuilt

File	File-Extension	Description
BIT-File	*.bit	FPGA (PL Part) Configuration File
DebugProbes-File	*.ltx	Definition File for Vivado/Vivado Labtools Debugging Interface
Diverse Reports	---	Report files in different formats
Xilinx Support Archive	*.xsa	Exported Vivado Hardware Specification for Vitis and PetaLinux
LabTools Project-File	*.lpr	Vivado Labtools Project File

File	File-Extension	Description
MCS-File	*.mcs	Flash Configuration File with Boot-Image (MicroBlaze or FPGA part only)
MMI-File	*.mmi	File with BRAM-Location to generate MCS or BIT-File with *.elf content (MicroBlaze only)
Software-Application-File	*.elf	Software Application for Zynq or MicroBlaze Processor Systems

Table 9: Prebuilt files (only on ZIP with prebuilt 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:

- TE0741 "Test Board" Reference Design[3]

3 https://shop.trenz-electronic.de/Download/?path=Trenz_Electronic/Modules_and_Module_Carriers/4x5/TE0741/Reference_Design/2021.2/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#XilinxSoftware-BasicUserGuides[4]
- Vivado Projects - TE Reference Design[5]
- Project Delivery.[6]

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[7]

> ⚠ **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"
3. Create project and follow instructions of the product selection guide, settings file will be configured automatically during this process.

4 https://wiki.trenz-electronic.de/display/PD/AMD+Development+Tools
5 https://wiki.trenz-electronic.de/display/PD/Vivado+Projects+-+TE+Reference+Design
6 https://wiki.trenz-electronic.de/display/PD/Project+Delivery+-+AMD+devices
7 https://wiki.trenz-electronic.de/display/PD/Project+Delivery+-+AMD+devices

- 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[8]

4. Create hardware description file (.xsa file) 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
   a. Run on Vivado TCL:

Script generates applications and bootable files, which are defined in "sw_lib\apps_list.csv"

```
TE::sw_run_vitis -all
```

   b. Copy "\prebuilt\software\<short name>\hello_te0741.elf" into "\firmware\microblaze_0\"
   c. (optional) Copy "\prebuilt\software\<short name>\scu.elf" into "\firmware\microblaze_mcs_0\"
   d. Regenerate Vivado Project or Update Bitfile only, with new "hello_te0741.elf" and "scu.elf"

   ⚠ TCL scripts generate also platform project, this must be done manually in case GUI is used. See Vitis[9]

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

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

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_te0741
```

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

6.1.3 SD-Boot mode

Not used on this Example.

6.1.4 JTAG

1. Connect JTAG and power on PCB

10 https://wiki.trenz-electronic.de/display/PD/AMD+Development+Tools

2. Open Vivado HW Manager
3. Program FPGA with Bitfile from "prebuilt\hardware\<short dir>\"

6.2 Usage

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. FPGA Loads Bitfile from Flash

   2. MCS Firmware configure SI5338 and starts Microblaze

   3. Hello TE0741 from Bitfile Example will be run on UART console.

   info: Do not reboot, if Bitfile programming over JTAG is used as programming method.

6.2.1 UART

Open Serial Console (e.g. putty)
   a. Speed: 9600
   b. COM Port: Win OS, see device manager, Linux OS see dmesg |grep tty (UART is *USB1)

```
Hello Trenz Module(TE0741) (Loop: 1)
Hello Trenz Module(TE0741) (Loop: 2)
Hello Trenz Module(TE0741) (Loop: 3)
Hello Trenz Module(TE0741) (Loop: 4)
Hello Trenz Module(TE0741) (Loop: 5)
```

6.2.2 Vivado HW Manager

Open Vivado HW-Manager and add VIO signal to dashboard (*.ltx located on prebuilt folder)

- Control:
  - LED_D1/D2 control
  - SI5338 25MHz REF CLK Enable
  - MGT Enable
- Monitoring:
  - Set radix from VIO signals (MGT...) to unsigned integer.
  - Note: Frequency Counter is inaccurate and displayed unit is Hz
  - MGT REFCLK1~125MHz, GT_REFCLK3~156,25MHz (default off, configured with MCS Firmware)
  - MGT Power Monitoring

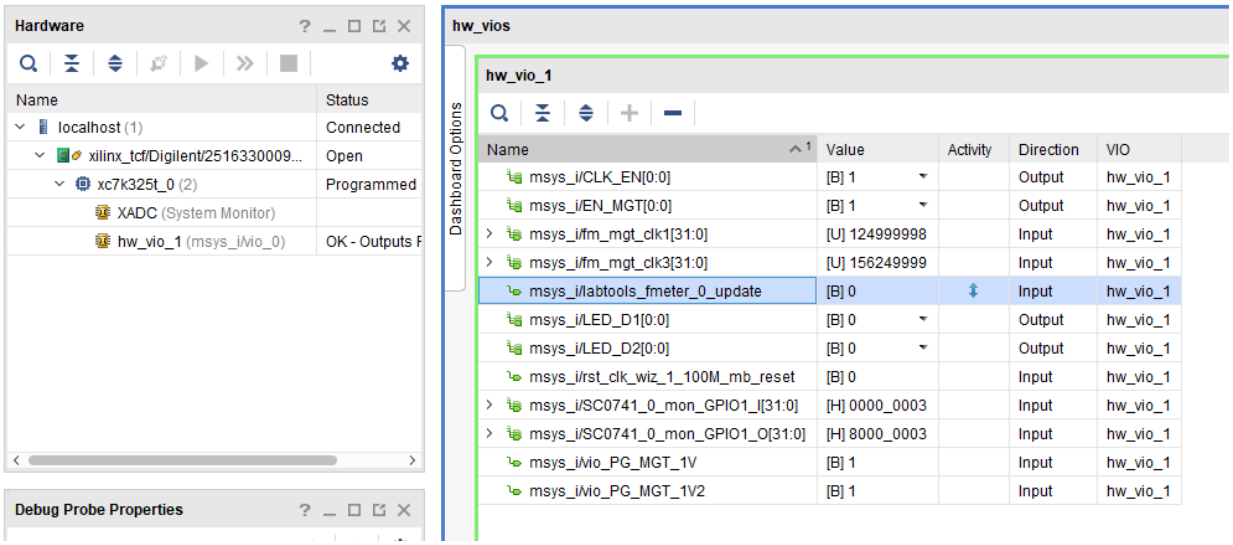

Figure 1: Vivado Hardware Manager

7 System Design - Vivado

7.1 Block Design

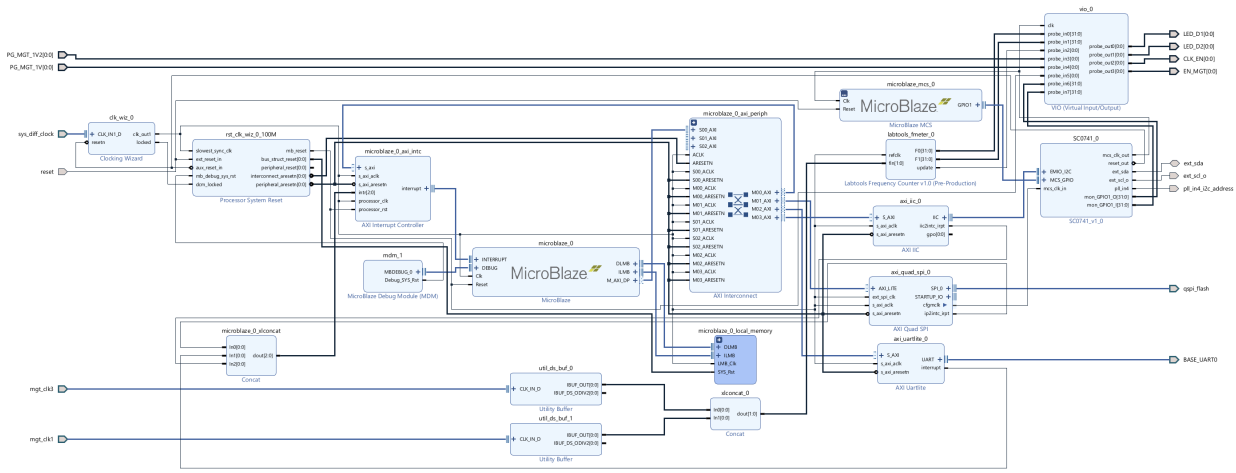

Figure 2: Block Design

7.2 Constraints

7.2.1 Basic module constraints

_i_bitgen_common.xdc

```
set_property BITSTREAM.GENERAL.COMPRESS TRUE [current_design]
set_property BITSTREAM.CONFIG.CONFIGRATE 66 [current_design]
set_property CONFIG_VOLTAGE 3.3 [current_design]
set_property CFGBVS VCCO [current_design]
set_property CONFIG_MODE SPIx4 [current_design]
set_property BITSTREAM.CONFIG.SPI_32BIT_ADDR YES [current_design]
set_property BITSTREAM.CONFIG.SPI_BUSWIDTH 4 [current_design]
set_property BITSTREAM.CONFIG.M1PIN PULLNONE [current_design]
set_property BITSTREAM.CONFIG.M2PIN PULLNONE [current_design]
set_property BITSTREAM.CONFIG.M0PIN PULLNONE [current_design]

set_property BITSTREAM.CONFIG.USR_ACCESS TIMESTAMP [current_design]
```

7.2.2 Design specific constraints

_i_io.xdc

```
#LED
```

```
set_property PACKAGE_PIN D26 [get_ports {LED_D1[0]}]
set_property IOSTANDARD LVCMOS33 [get_ports {LED_D1[0]}]
set_property PACKAGE_PIN E26 [get_ports {LED_D2[0]}]
set_property IOSTANDARD LVCMOS33 [get_ports {LED_D2[0]}]
#MGT Power
set_property PACKAGE_PIN G25 [get_ports {PG_MGT_1V2[0]}]
set_property IOSTANDARD LVCMOS33 [get_ports {PG_MGT_1V2[0]}]
set_property PACKAGE_PIN K23 [get_ports {PG_MGT_1V[0]}]
set_property IOSTANDARD LVCMOS33 [get_ports {PG_MGT_1V[0]}]
set_property PACKAGE_PIN H22 [get_ports {EN_MGT[0]}]
set_property IOSTANDARD LVCMOS33 [get_ports {EN_MGT[0]}]
#SI5338 CLK
set_property PACKAGE_PIN C26 [get_ports {CLK_EN[0]}]
set_property IOSTANDARD LVCMOS33 [get_ports {CLK_EN[0]}] #I2C PLL SI5338
#I2C PLL SI5338
set_property PACKAGE_PIN A20 [get_ports ext_scl_o]
set_property IOSTANDARD LVCMOS33 [get_ports ext_scl_o]
set_property PACKAGE_PIN B21 [get_ports ext_sda]
set_property IOSTANDARD LVCMOS33 [get_ports ext_sda]
set_property PACKAGE_PIN B20 [get_ports pll_in4_i2c_address]
set_property IOSTANDARD LVCMOS33 [get_ports pll_in4_i2c_address]


set_property IOSTANDARD LVCMOS33 [get_ports reset]
set_property PACKAGE_PIN L23 [get_ports reset]
set_property PACKAGE_PIN C23 [get_ports qspi_flash_ss_io]
set_property IOSTANDARD LVCMOS33 [get_ports qspi_flash_ss_io]
set_property PACKAGE_PIN B24 [get_ports qspi_flash_io0_io]
set_property IOSTANDARD LVCMOS33 [get_ports qspi_flash_io0_io]
set_property PACKAGE_PIN A25 [get_ports qspi_flash_io1_io]
set_property IOSTANDARD LVCMOS33 [get_ports qspi_flash_io1_io]
set_property PACKAGE_PIN B22 [get_ports qspi_flash_io2_io]
set_property PACKAGE_PIN A22 [get_ports qspi_flash_io3_io]
set_property IOSTANDARD LVCMOS33 [get_ports qspi_flash_io2_io]
set_property IOSTANDARD LVCMOS33 [get_ports qspi_flash_io3_io]
```

_i_timing.xdc

```
#Fmeter can be ignored, it's only simple measurement

set_false_path -from [get_pins {msys_i/labtools_fmeter_0/U0/
FMETER_gen[*].COUNTER_F_inst/bl.DSP48E_2/CLK}] -to [get_pins {msys_i/
labtools_fmeter_0/U0/F_reg[*]/D}]

set_false_path -from [get_pins msys_i/labtools_fmeter_0/U0/toggle_reg/C] -to
[get_pins {msys_i/labtools_fmeter_0/U0/FMETER_gen[*].COUNTER_F_inst/bl.DSP48E_2/
RSTC}]
set_false_path -from [get_pins msys_i/labtools_fmeter_0/U0/toggle_reg/C] -to
[get_pins {msys_i/labtools_fmeter_0/U0/FMETER_gen[*].COUNTER_F_inst/bl.DSP48E_2/
RSTA}]
set_false_path -from [get_pins msys_i/labtools_fmeter_0/U0/toggle_reg/C] -to
[get_pins {msys_i/labtools_fmeter_0/U0/FMETER_gen[*].COUNTER_F_inst/bl.DSP48E_2/
RSTB}]
```

```
set_false_path -from [get_pins msys_i/labtools_fmeter_0/U0/toggle_reg/C] -to
[get_pins {msys_i/labtools_fmeter_0/U0/FMETER_gen[*].COUNTER_F_inst/bl.DSP48E_2/
CEALUMODE}]
set_false_path -from [get_pins msys_i/labtools_fmeter_0/U0/toggle_reg/C] -to
[get_pins {msys_i/labtools_fmeter_0/U0/FMETER_gen[*].COUNTER_F_inst/bl.DSP48E_2/
RSTCTRL}]

set_false_path -from [get_clocks -of_objects [get_pins msys_i/clk_wiz_0/inst/
mmcm_adv_inst/CLKOUT0]] -to [get_clocks mgt_clk1_clk_p]
set_false_path -from [get_clocks -of_objects [get_pins msys_i/clk_wiz_0/inst/
mmcm_adv_inst/CLKOUT0]] -to [get_clocks mgt_clk3_clk_p]
```

8 Software Design - Vitis

For Vitis project creation, follow instructions from:

Vitis[11]

8.1 Application

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

8.1.1 SCU

MCS Firmware to configure SI5338 and Reset System.

Template location: \sw_lib\sw_apps\scu

8.1.2 Hello TE0741

Xilinx Hello World example as endless loop

Template location: \sw_lib\sw_apps\hello_te0741

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

9 Additional Software

9.1 SI5338

File location "<project folder>\misc\Si5338\Si5338-*.slabtimeproj"

General documentation how you work with this project will be available on Si5338[12]

12 https://wiki.trenz-electronic.de/display/PD/Si5338

10 App. 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
2022-06-09	v.9[13]	Waldemar Hanemann[14]	• pll_in4 - i2c address pin pulled to zero in System Controller ip • added new variants
2022-03-15	v.8	Waldemar Hanemann	• update 2021.2
2018-05-15	v.7	John Hartfiel	• Release 2017.4 • small description update
2018-04-16	v.1	John Hartfiel	• initial release
--	all	John Hartfiel[15] , Waldemar Hanemann[16]	--

Table 10: Document change history.

10.2 Legal Notices

10.3 Data Privacy

Please also note our data protection declaration at https://www.trenz-electronic.de/en/Data-protection-Privacy

13 https://wiki.trenz-electronic.de/pages/viewpage.action?pageId=214073409
14 https://wiki.trenz-electronic.de/display/~w.hanemann
15 https://wiki.trenz-electronic.de/display/~j.hartfiel
16 https://wiki.trenz-electronic.de/display/~w.hanemann

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17 http://guidance.echa.europa.eu/

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2019-06-07

18 https://echa.europa.eu/candidate-list-table
19 http://www.echa.europa.eu/