CON-FMC User Manual

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Future Design Systems, Inc.
www.future-ds.com / contact@future-ds.com

Abstract

CON-FMC is an USB3.0 interface board complying with ANSI/VITA 57.1-2008, FPGA Mezzanine Card (FMC) standard.

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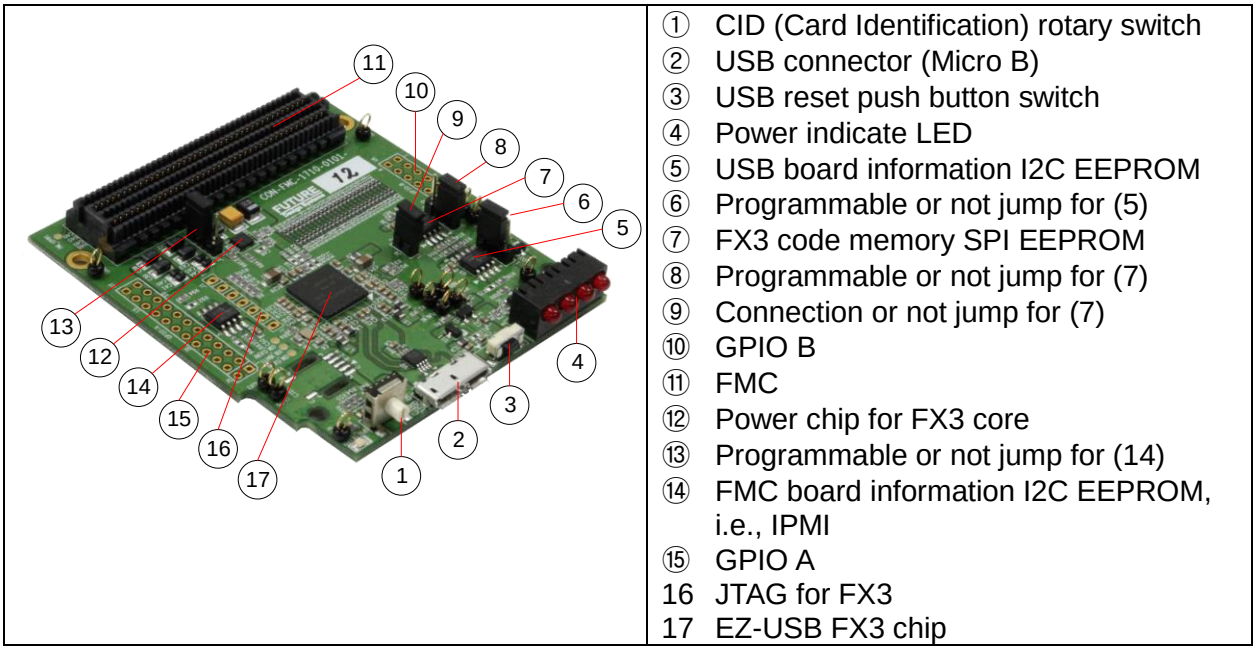
1 Overview

CON-FMC is an USB3.0 interface board complying with ANSI/VITA 57.1-2008, FPGA Mezzanine Card (FMC) standard.

1.1 CON-FMC board

Figure 1 shows CON-FMC PBA (Printed Board Assembly) Version 1710-0101.



①	CID (Card Identification) rotary switch
②	USB connector (Micro B)
③	USB reset push button switch
④	Power indicate LED
⑤	USB board information I2C EEPROM
⑥	Programmable or not jump for (5)
⑦	FX3 code memory SPI EEPROM
⑧	Programmable or not jump for (7)
⑨	Connection or not jump for (7)
⑩	GPIO B
⑪	FMC
⑫	Power chip for FX3 core
⑬	Programmable or not jump for (14)
⑭	FMC board information I2C EEPROM, i.e., IPMI
⑮	GPIO A
16	JTAG for FX3
17	EZ-USB FX3 chip

Figure 1: CON-FMC PBA board

Figure 2 shows mechanical dimension of CON-FMC and it complies with ANSI/VITA 57.1 standard.

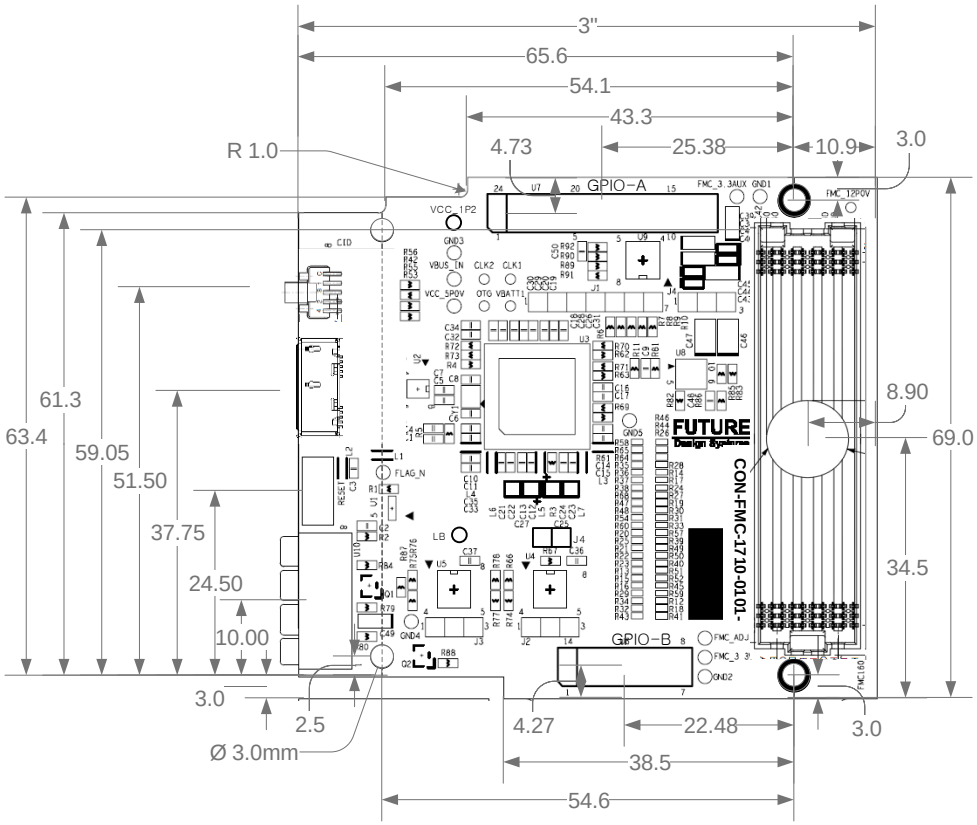


Figure 2: CON-FMC mechanical dimension

1.2 Block diagram

Figure 3 shows block diagram of CON-FMC.

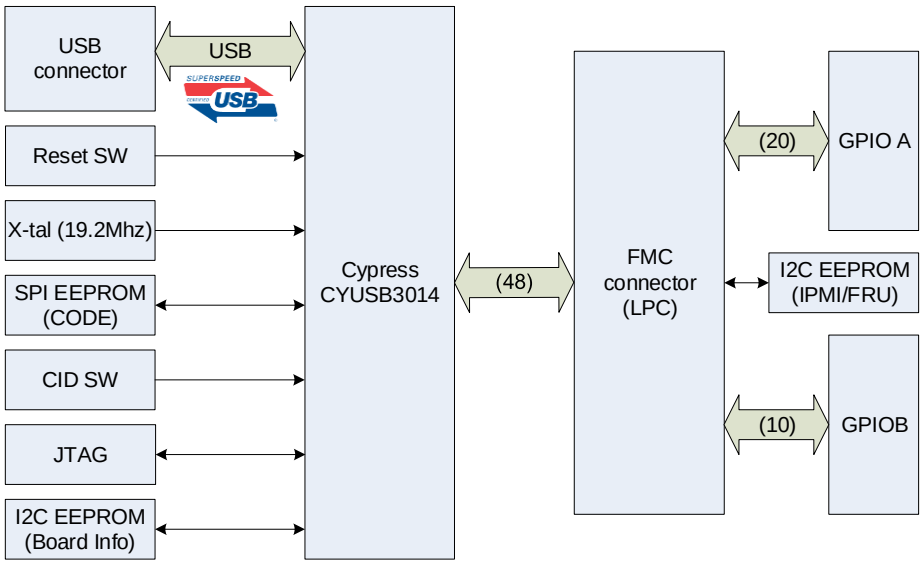


Figure 3: CON-FMC block diagram

1.3 Supporting environment

1.3.1 Host computer

CON-FMC supports industry standard platforms including Windows, Linux, and Android.

- Linux
  - ✧ Ubuntu Release 16.04, Kernel 4.15.0-24-generic, x86_64[1]
  - ✧ Ubuntu Release 16.04, arm7l[2]
  - ✧ Raspbian, arm7l[3]
- Windows
- Android

1.3.2 FPGA board (Carrier board)

CON-FMC can be used with FMC supporting FPGA board, which includes LPC, HPC, and HPC+. Refer to 'Section 11 Carrier board constraints' for more details,

2 Hardware

2.1 Power

CON-FMC uses two DC power sources; one from USB and the other from FMC. As a result, there is no need to additional power for CON-FMC.

- The former (5Vdc from USB) is fed to FX3 for USB connection
- The latter (from FMC) is divided further in to three
  - ✧ 3.3V for FMC board information EEPROM
  - ✧ 3.3V fixed for not FMC connected pins of FX3 including FX3 core
  - ✧ FMC VADJ for FMC connected pins of FX3
    - ✓ Actual voltage is determined by the value of certain field of FMC board information EEPROM that contains IPMI/FRU.

[1] Intel PC
[2] Odroid
[3] Raspberry Pi

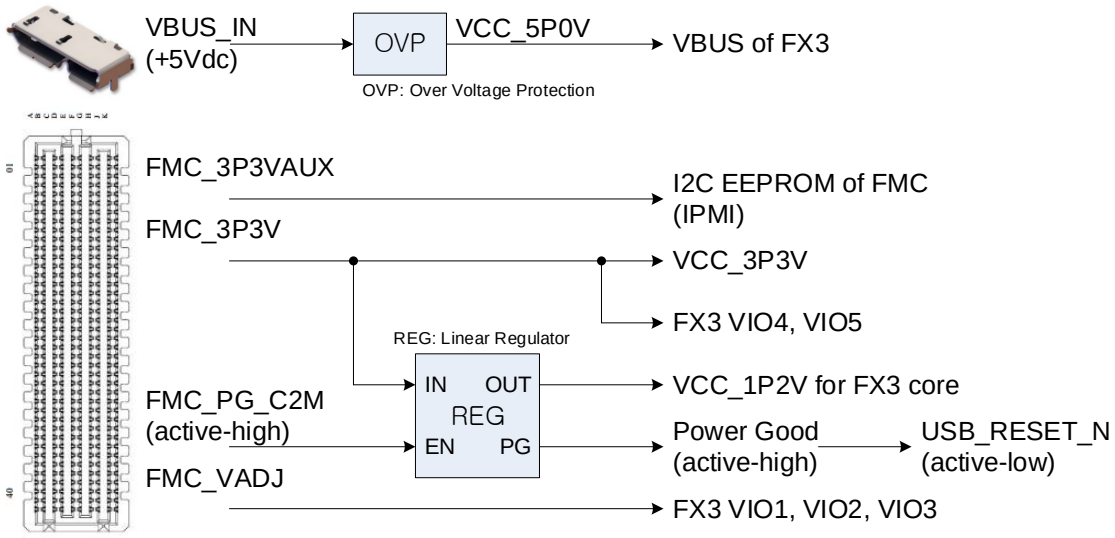


Figure 4: CON-FMC power plan

2.2 LED

Figure 5 shows LEDs, which indicate status of power.

- VADJ (FMC): FMC main power for most FMC signal pins
- 3.3V (FMC): FMC 3.3V power
- 1.2V (FMC → FX3): FX3 core 12V voltage derived from FMC 3.3V
- 5.0V (USB): User bus power

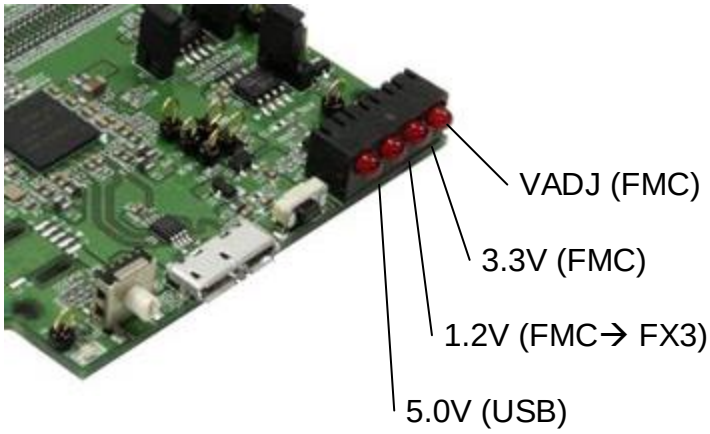


Figure 5: LED indicating power status

2.3 Switches and jumps

Location of switches and jumps can be found from Figure 6.

- CID rotary switch (1)
  - ✧ It provides 3-bit binary to FX3 GPIO (52, 51, 50).

- USB reset switch (3)
  - ✧ It causes reset to FX3 and makes initialize FX3.
- USB board information PROM program jump (6)
  - ✧ See Figure 6
- FX3 code PROM program jump (8)
  - ✧ See Figure 6
- FX3 code PROM connection jump (9)
  - ✧ It connects MISO signal lines in order to boot FX3 from PROM.
  - ✧ It should be removed to boot FX3 from internal code.
  - ✧ See Figure 6
- FMC board information PROM program jump (13)
  - ✧ This jump should remain in protected. (1-2 connected)

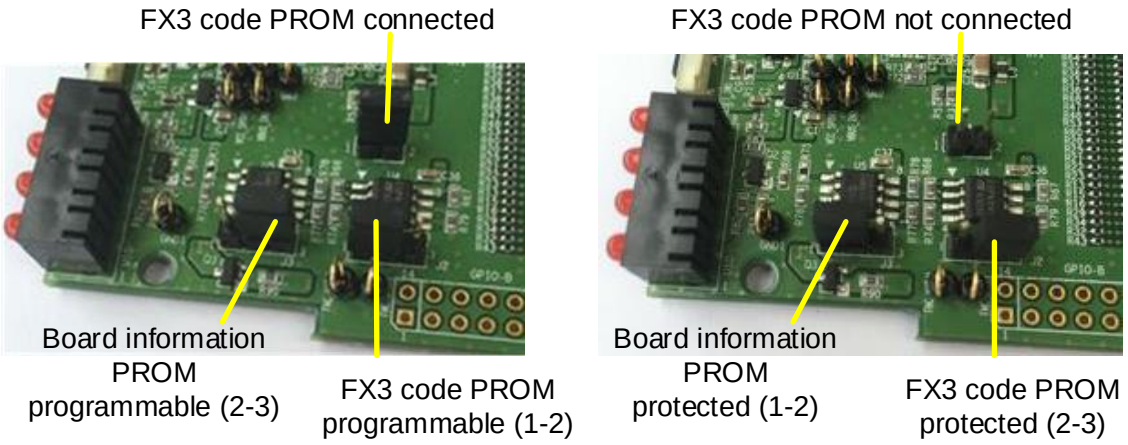


Figure 6: Jump settings

2.4 FMC connector

FMC pins are divided in to groups as shown in Figure 7.

- Power group
- EZ-USB FX3 GPIF II group: 48 pins are connected to EX-USB FX3 chip
- Board information PROM group+
- USERGPIO group
- JTAG loop from carrier board (not connected to any in the FMC board)

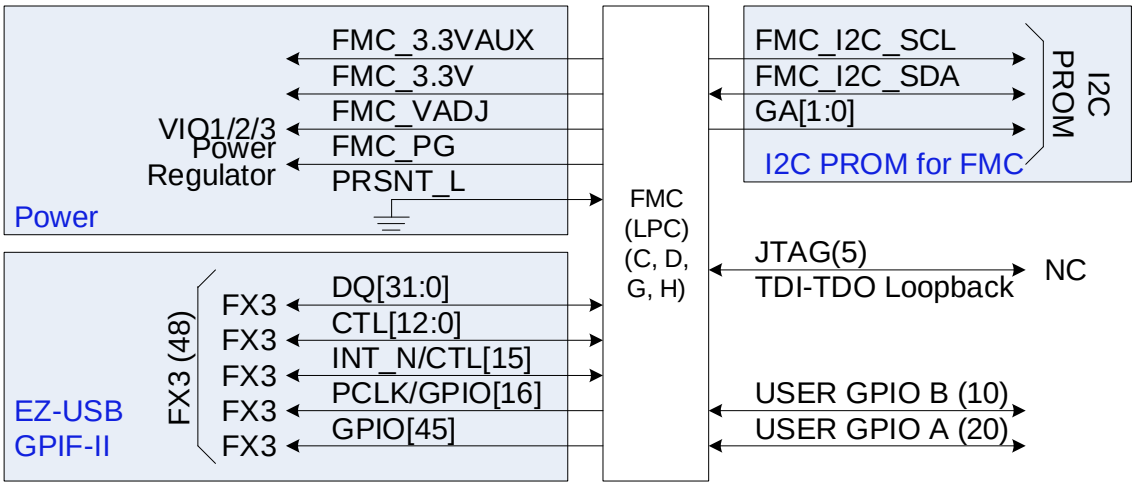


Figure 7: FMC pins

Details of pin assignment is given in ‘Section 7 FMC pin assignment’.

2.5 USER GPIO A and B

GPIO A provides 20 pins from FMC to CON-FMC and GPIO B provides 10 pins from FMC to CON-FMC. The signal voltage is determined by FMC_VADJ.

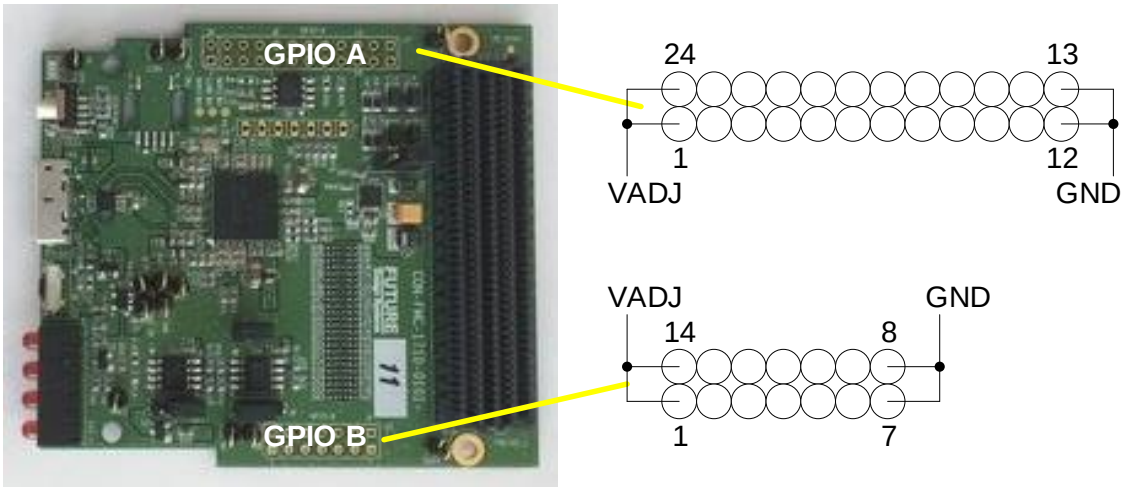


Figure 8: GPIO A and B

3 Software installation

Figure 9 shows conceptual structure of how ‘user application’ interacts with ‘user design’ in the FPGA through CON-FMC, where CON-FMC connects the

host computer and the FPGA through USB3.0 using Cypress EZ-USB FX3 chipset[4].

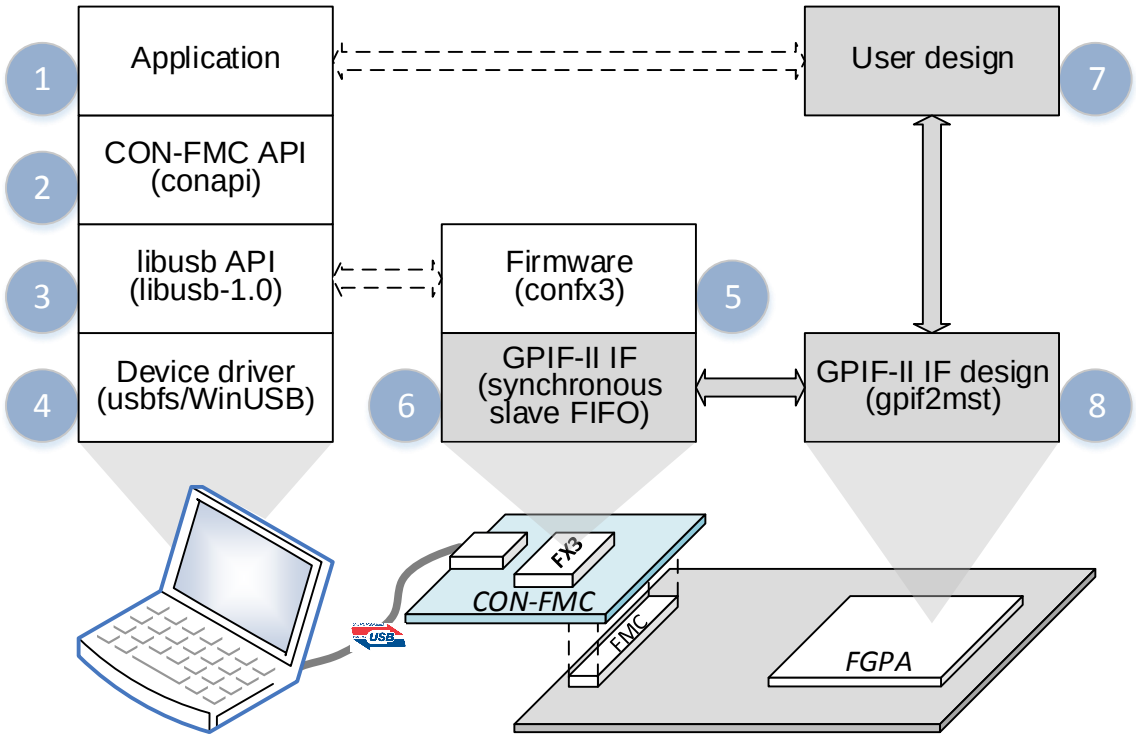


Figure 9: CON-FMC software environment

This section is about installing LIBUSB API (3), ad CON-FMC API (2).

3.1 Ubuntu for Intel x86 64-bit

It requires 'LibUsb[5]' and if it is not ready[6] then install it as follows.

```
$ dpkg –l libusb-1.0*
// if libusb is not installed, then install
$ sudo apt-get install libusb-1.0.0-dev
```

Get CON-FMC package such as 'confmc.x86_64.linux.tgz'. Untar it and run 'coninstall.sh' with root permission.

```
$ tar xfz confmc.x86_64.linux.tgz
$ cd confmc.x86_64.linux
$ sudo ./coninstall.sh
```

[4] Cypress Semiconductor, EZ-USB FX3 SuperSpeed USB Controller, CYUSB301X, 2012.
[5] LibUSB is a user-space USB library.
[6] Try "$ ldconfig –p | grep libusb" to figure out if LibUSB is installed or not.

```
// follow on-screen instructions
// re-boot the system if required.
```

By default, the CON-FMC package is installed at '/opt/confmc/2018.05'.

Run following script before using CON-FMC.

```
$ . /opt/confmc/2018.05/settings.sh
// this set 'CONFMC_HOME' environment variable
```

3.2 CentOS for Intel x86 64-bit

It requires 'LibUsb' and if it is not ready then install it as follows.

```
$ rpm –qa | grep -i libusb
// if libusb1-1.0.* and libusb1-devel-1.0.* are missing, then install
$ sudo yum install libusb-1.0.0-dev
```

Get CON-FMC package such as 'confmc.x86_64.linux.tgz'. Untar it and run 'coninstall.sh'.

```
$ tar xfz confmc.x86_64.linux.tgz
$ cd confmc.x86_64.linux
$ sudo ./coninstall.sh
// follow on-screen instructions
// re-boot the system if required.
```

By default, the CON-FMC package is installed at '/opt/confmc/2018.05'.

Run following script before using CON-FMC.

```
$ . /opt/confmc/2018.05/settings64.sh
// this set 'CONFMC_HOME' environment variable
```

3.3 Ubuntu for ARMv7 32-bit

This is about ARM-based platforms including Raspberry Pi, Odroid, and ARTIK.

It requires 'LibUsb[7]' and if it is not ready[8] then install it as follows.

```
$ dpkg –l libusb-1.0*
// if libusb is not installed, then install
$ sudo apt-get install libusb-1.0.0-dev
```

Get CON-FMC package such as 'confmc.armv7l.ubuntu_16.04.tgz'. Untar it and run 'coninstall.sh' with root permission.

[7] LibUSB is a user-space USB library.
[8] Try "$ ldconfig –p | grep libusb" to figure out if LibUSB is installed or not.

```
$ tar xfz confmc.armv7l.ubuntu_16.04.tgz
$ cd confmc.armv7l.ubuntu_16.04
$ sudo ./coninstall.sh
// follow on-screen instructions
// re-boot the system if required.
```

By default, the CON-FMC package is installed at '/opt/confmc/2018.05'.

Run following script before using CON-FMC.

```
$ . /opt/confmc/2018.05/settings.sh
// this set 'CONFMC_HOME' environment variable
```

3.4 Windows

To be added

3.5 Android

To be added

4 Software API

Refer to 'CON-FMC API based on LIBUSB'.

5 FPGA design tips

Figure 10 shows an interface of EZ-USB FX3 GPIF-II. In terms of 'user design', this interface does not matter since 'user design' only uses FIFO IF.

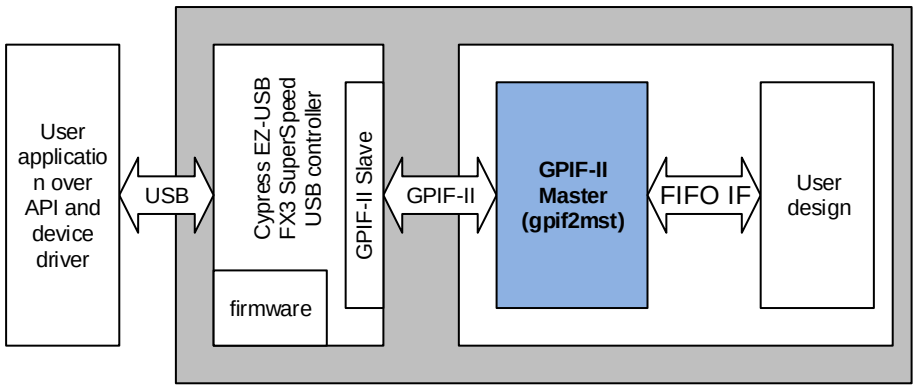


Figure 10: GPIF-II interfaces

Figure 11 shows conceptual interface for ‘user design’, which uses dual-ready FIFO interface such as data in ‘data[…]’ is moved at the rising edge of ‘clk’ when both ‘ready’ and ‘valid’ are one.

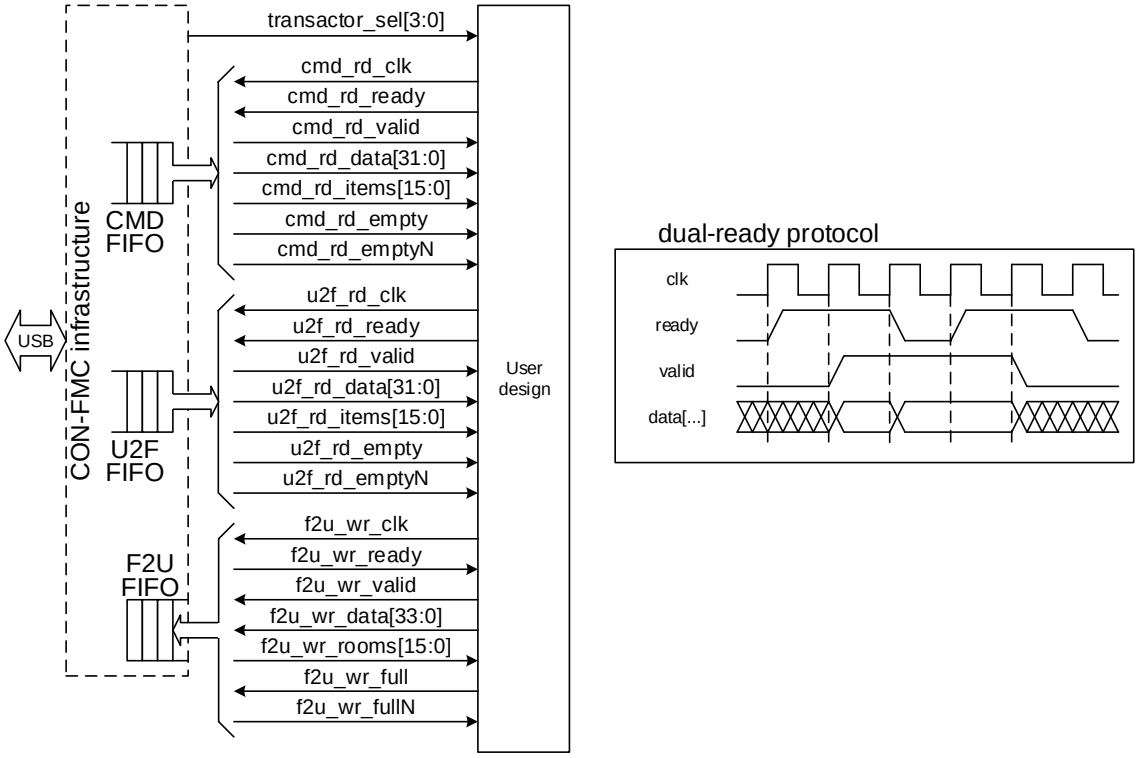


Figure 11: User side interface

It should be noted that ‘items[...]’ and ‘rooms[...]’ indicate guaranteed value not exact value, where ‘items[...]’ reflects the number of items can be read and ‘rooms[...]’ reflects the number of rooms ca be written.

‘f2u_data[33:32]’ are used to control end-of-packet or zero-length-packet. If you are not familiar with USB protocol, just tie them 0.

It is highly recommeded to copy example design in ‘$CONFMC_HOME/examples’ directory[9] and then modify it as you need.

- use ‘fex_0001_loopback’ for FIFO interface

5.1 AMBA buses

There are many on-chip bueses and AMBA family is one of most popular industrial standard bues. CON-FMC supports the AMBA bus.

[9] ‘CONFMC_HOME’ is a default macro indicating the directory where CON-FMC package reside, e.g., /opt/confmc/2018.05.

It is highly recommeded to copy example design in '$CONFMC_HOME/examples' directory[10] and then modify it as you need.

- use 'fex_0002_amba_ahb_mem' for AMBA AHB interface
- use 'fex_0003_amba_axi_mem' for AMBA AXI interface

6 FX3 pin assignment

(If you need more details, please contact at contact@future-ds.com).

Name	Ref name	Remarks
GPIO0_DQ0	SL_DT[0]	
GPIO1_DQ1	SL_DT[1]	
GPIO2_DQ2	SL_DT[2]	
GPIO3_DQ3	SL_DT[3]	
GPIO4_DQ4	SL_DT[4]	
GPIO5_DQ5	SL_DT[5]	
GPIO6_DQ6	SL_DT[6]	
GPIO7_DQ7	SL_DT[7]	
GPIO8_DQ8	SL_DT[8]	
GPIO9_DQ9	SL_DT[9]	
GPIO10_DQ10	SL_DT[10]	
GPIO11_DQ11	SL_DT[11]	
GPIO12_DQ12	SL_DT[12]	
GPIO13_DQ13	SL_DT[1]3	
GPIO14_DQ14	SL_DT[1]4	
GPIO15_DQ15	SL_DT[1]5	
GPIO16_PCLK	SL_PCLK	
GPIO17_CTL0		
GPIO18	SL_WR_N	
GPIO19	SL_OE_N	
GPIO20	SL_RD_N	
GPIO21	SL_FLAGA	
GPIO22	SL_FLAGB	
GPIO23	SL_FLAGC	
GPIO24	SL_PKTEND_N	
GPIO25	SL_FLAGD	
GPIO26	SL_RST_N	
GPIO27	SL_MODE[0]	
GPIO28		
GPIO29_CTL12		
GPIO30	PMODE0	1
GPIO31	PMODE1	Float
GPIO32	PMODE2	0
GPIO33	SL_DT[16]	
GPIO44	SL_DT[27]	
GPIO45	SL_MODE[1]	
GPIO46	SL_DT[28]	
GPIO47	SL_DT[29]	

[10] 'CONFMC_HOME' is a default macro indicating the directory where CON-FMC package reside, e.g., /opt/confmc/2018.05.

GPIO48	SL_DT[30]	
GPIO49	SL_DT[31]	
GPIO50	CID[0]	
GPIO51	CID[1]	
GPIO52	CID[2]	
GPIO53	SPI_SCK	FX3 code PROM
GPIO54	SPI_SSN	FX3 code PROM
GPIO55	SPI_MISO	FX3 code PROM
GPIO56	SPI_MOSI	FX3 code PROM
GPIO57	LB_LED	
GPIO58	I2C_SCLK	Board information PROM
GPIO59	I2C_SDA	Board infromation PROM
GPIO60	N.C	

7 FMC pin assignment

FMC Pin	Signal Name	GPIF-II Signal		GPIO A pin	GPIO B pin
C1	GND				
C2	FMC_DP0_C2M_P				2
C3	FMC_DP0_C2M_N				13
C4	GND				
C5	GND				
C6	FMC_DP0_M2C_P				3
C7	FMC_DP0_M2C_N				12
C8	GND				
C9	GND				
C10	USB_GPIO12	SL_DT[12]			
C11	USB_GPIO13	SL_DT[13]			
C12	GND				
C13	GND				
C14	USB_GPIO20	SL_RD_N			
C15	USB_GPIO21	SL_FLAGA			
C16	GND				
C17	GND				
C18	USB_GPIO28	SL_AD[1]			
C19	USB_GPIO29	SL_AD[0]			
C20	GND				
C21	GND				
C22	USB_GPIO39	GPIO39			
C23	USB_GPIO40	GPIO40			
C24	GND				
C25	GND				
C26	FMC_LA27_P				6

C27	FMC_LA27_N				9
C28	GND				
C29	GND				
C30	FMC_SCL				
C31	FMC_SDA				
C32	GND				
C33	GND				
C34	FMC_GA0				
C35	FMC_12P0V				
C36	GND				
C37	FMC_12P0V				
C38	GND				
C39	FMC_3P3V				
C40	GND				
D1	FMC_PG_C2M				
D2	GND				
D3	GND				
D4	FMC_GBTCLK0_M2C_P				4
D5	FMC_GBTCLK0_M2C_N				11
D6	GND				
D7	GND				
D8	USB_GPIO02	SL_DT[2]			
D9	USB_GPIO03	SL_DT[3]			
D10	GND				
D11	USB_GPIO10	SL_DT[10]			
D12	USB_GPIO11	SL_DT[11]			
D13	GND				
D14	USB_GPIO18	SL_WR_N			
D15	USB_GPIO19	SL_OE_N			
D16	GND				
D17	USB_GPIO26	SL_RST_N			
D18	USB_GPIO27	SL_MODE[0]	LA13_N		
D19	GND				
D20	USB_GPIO37	GPIO37			
D21	USB_GPIO38	GPIO38			
D22	GND				
D23	USB_GPIO49	GPIO49			
D24	USB_INT_N	USB_INT_N			

D25	GND				
D26	FMC_LA26_P				5
D27	FMC_LA26_N				10
D28	GND				
D30	FMC_TDI				
D31	FMC_TDO				
D32	FMC_3P3VAUX				
D35	FMC_GA1				
D36	FMC_3P3V				
D37	GND				
D38	FMC_3P3V				
D39	GND				
D40	FMC_3P3V				
G1	GND				
G2	FMC_CLK1_M2C_P			3	
G3	FMC_CLK1_M2C_N			22	
G4	GND				
G5	GND				
G6	USB_GPIO00	SL_DT[0]			
G7	USB_GPIO01	SL_DT[1]			
G8	GND				
G9	USB_GPIO06	SL_DT[6]			
G10	USB_GPIO07	SL_DT[7]			
G11	GND				
G12	USB_GPIO16	SL_PCLK			
G13	USB_GPIO17	GPIO17			
G14	GND				
G15	USB_GPIO24	SL_PKTEND_N	LA12_P		
G16	USB_GPIO25	SL_FLAGD			
G17	GND				
G18	USB_GPIO35	GPIO35			
G19	USB_GPIO36	GPIO36			
G20	GND				
G21	USB_GPIO43	GPIO43			
G22	USB_GPIO44	GPIO44			
G23	GND				
G24	USB_GPIO47	GPIO47			
G25	USB_GPIO48	GPIO48			

G26	GND				
G27	FMC_LA25_P			5	
G28	FMC_LA25_N			20	
G29	GND				
G30	FMC_LA29_P			7	
G31	FMC_LA29_N			18	
G32	GND				
G33	FMC_LA31_P			9	
G34	FMC_LA31_N			16	
G35	GND				
G36	FMC_LA33_P			11	
G37	FMC_LA33_N			14	
G38	GND				
G39	VCC_VADJ				
G40	GND				
H2	GND				
H3	GND				
H4	FMC_CLK0_M2C_P			2	
H5	FMC_CLK0_M2C_N			23	
H6	GND				
H7	USB_GPIO04	SL_DT[4]			
H8	USB_GPIO05	SL_DT[5]			
H9	GND				
H10	USB_GPIO08	SL_DT[8]			
H11	USB_GPIO09	SL_DT[9]			
H12	GND				
H13	USB_GPIO14	SL_DT[14]			
H14	USB_GPIO15	SL_DT[15]			
H15	GND				
H16	USB_GPIO22	SL_FLAGB			
H17	USB_GPIO23	SL_FLAGC			
H18	GND				
H19	USB_GPIO33	GPIO33			
H20	USB_GPIO34	GPIO34			
H21	GND				
H22	USB_GPIO41	GPIO41			
H23	USB_GPIO42	GPIO42			
H24	GND				

H25	USB_GPIO45	SL_MODE[1]	LA21_P		
H26	USB_GPIO46	GPIO46			
H27	GND				
H28	FMC_LA24_P			4	
H29	FMC_LA24_N			21	
H30	GND				
H31	FMC_LA28_P			6	
H32	FMC_LA28_N			19	
H33	GND				
H34	FMC_LA30_P			8	
H35	FMC_LA30_N			17	
H36	GND				
H37	FMC_LA32_P			10	
H38	FMC_LA32_N			15	
H39	GND				
H40	VCC_VADJ				

8 Board information

CON-FMC has an I2C EEPROM (Figure 1 component 5) that contains board information, which is accessed through USB channel. *It is not recommended user to modify its contents*.[11]

9 Code memory

CON-FMC has an SPI EEPROM (Figure 1 component 7) that contains code, which is accessed by the USB controller. *It is not recommended user to modify its contents*.[12]

10 IPMI (Intelligent Platform Management Interface)

CON-FMC has an I2C EEPROM (Figure 1 component 14) that contains board information supporting Field Replaceable Unit (FRU) Information, which is accessed through FMC channel. *It is not recommended user to modify its contents*.[13]

11 Carrier board constraints

[11] CON-FMC API may not work when its contents altered.
[12] CON-FMC may not be detected by the host computer when its contents altered.
[13] FPGA carrier board may not work when its contents altered.

UCF or XDC are available in the example directory. Consult with Future Design Systems for additional boards.

11.1 Xilinx SP605: Spartan-6 xc6slx45t

$CONFMC_HOME/examples/fex_0001_loopback/hw.single/pnr/ise.sp605.lpc/ucf

11.2 Xilinx ML605: Virtex-6 xc6vlx240t

$CONFMC_HOME/examples/fex_0001_loopback/hw.single/pnr/ise.ml605.lpc/ucf

11.3 Xilinx ZC706: Zynq-7000 xc7z045

$CONFMC_HOME/examples/fex_0001_loopback/hw.single/pnr/vivado.zc706.lpc/xdc

11.4 Xilinx VCU108: Virtex UltraScale xcvu095

$CONFMC_HOME/examples/fex_0001_loopback/hw.single/pnr/vivado.vcu108.hpc0/xdc

11.5 Xilinx ZC702: Zynq-7000 xc7z020

$CONFMC_HOME/examples/fex_0001_loopback/hw.single/pnr/vivado.zc702.lpc0/xdc

11.6 Avnet ZedBoard: Zynq-7000 xc7z020

$CONFMC_HOME/examples/fex_0001_loopback/hw.single/pnr/vivado.zed.lpc/xdc

12 Trouble shooting

12.1 undefined reference to ‘libusb_sterror’

- Symptom: Compiler exits with following error.

```
undefined reference to `libusb_strerror'
```

- Reason: LibUSB version is lower than required since ‘libconapi.a’ needs LibUSB version 1.0.22 or higher.
- Solution: Install latest LibUSB.

The version of LibUSB of CON-FMC library can be found from ‘libusb_version.txt’ in $CONFMC_HOME/include directory. The version of LibUSB of system can be found from ‘libusb.h’ in ‘/usr/include/libusb-1.0’ directory, where ‘LIBUSB_API_VERSION'

Wish list

- ☐

Related documents

[1] Future Design Systems, CON-FMC API based on LIBUSB, FDS-TD-2018-04-004.
[2] Future Design Systems, Board information format for I2C PROM, FDS-TD-2018-04-001. (Internal document)
[3] Future Design Systems, Cypress EZ-USB FX3 GPIF-II firmware for CON-FMC, FDS-TD-2018-04-003. (Internal document)
[4] Future Design Systems, IPMI handling program user guide, FDS-TD-2017-12-001. (Internal document)

Revision history

- ☐ 2018.08.14: ‘12. Trouble shooting’ added by Ando Ki.
- ☐ 2018.07.13: ‘Related documents’ added by Ando Ki.
- ☐ 2018.06.06: LED picture added by Ando Ki.
- ☐ 2018.03.15: Document started by Ando Ki (adki@future-ds.com)

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