

FPGA Software Installation and Firmware Update Instructions

AMD Versal Plus Ryzen Mini-ITX Board VPR-4616-MB

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SAPPHIRE - Embedded+ Initial Platform Install & Config

This page captures the steps to bring-up the <u>Embedded+</u> platform configuration for the x86 Host and Versal SoC device enablement.

Hardware Setup:

Embedded+ system is comprised of a Versal SoC and a Ryzen SoC. The primary interfaces between these SoCs are PCIe and JTAG. Users interact with the Ryzen SoC through conventional means such as a keyboard and monitor, or via SSH once Linux is installed. Two UART ports are connected to the Versal SoC for debugging purposes only; they are not intended as the primary interface for Embedded+.

This documentation assumes the user possesses an Embedded+ system with OSPI pre-programmed at the factory, as this is the standard shipping configuration. The user will install Linux on the Ryzen X86 first, enabling subsequent interfacing with the Versal SoC.

x86 Host OS

This section guide user to install Linux on X86. The Embedded+ platform's X86 host XRT driver for Embedded+ has been validated with Ubuntu 22.04 OS and the XRT Ubuntu library is aligned with the GA 5.15 Linux kernel. Thus, if the default installed Ubuntu image is using a later kernel, the following steps are required to update the x86 Ubuntu OS to be aligned:

- These steps are necessary for VPR-4616-MB only. VPR-4616-SYS has preloaded software and this section is not necessary.
 - 1. Install the x86 host OS. Instructions and the image are available directly from Canonical:
 - a Requires a USB stick, keyboard, monitor, mouse, and ethernet connection
 - b Install instructions: https://ubuntu.com/tutorials/install-ubuntu-desktop#1-overview
 - c OS image download: <u>https://releases.ubuntu.com/jammy/</u>
 - 2. Once the x86 host OS is installed and booted from its SSD. Update the kernel to the 5.15 generic kernel with these steps
 - a. Install the generic kernel

Generic kernel install

sudo apt install linux-image-generic sudo apt install -f

b. Replace the "GRUB_DEFAULT" string in: /etc/default/grub with GRUB_DEFAULT="Advanced options for Ubuntu>Ubuntu, with Linux 5.15.0-####_generic".

Note that the ### in the string above needs to be aligned with the generic kernel number used in the install of the previous step

c. Update grub config & reboot:

Kernel upda	ate	
sudo update-g	şrub	
sudo reboot n	OW	

3. Validate the kernel update using:

Validate kernel	
uname -r	

- 4. Install the XRT drivers on the x86 host. The Embedded+ platform support is now only be built in the 2024.1 XRT builds. This is NOT required to be aligned to the Embedded+ 2023.2 HW shell designs.
 - a Get the latest XRT *xrt_202410.<date>_22.04-amd64-xrt.deb* from the automated builds at: <u>https://www.xilinx.com/member/forms/download/xef.html?filename=xrt_202410.2.17.326</u> <u>_22.04-amd64-xrt.deb</u>

(i) xrt version

Ensure that the XRT version is 2.17.306 or later.

- b Move xrt.deb package to the Embedded+ platform running Ubuntu 22.04
- c Install the 5.15 headers. Use the ### associated with the generic kernel installed.

Generic kernel headers

sudo apt install linux-headers-\$(uname -r)

d Install the xrt package with:

Install XRT driver

sudo dpkg -i xrt_202410.<date>_22.04-amd64-xrt.deb

e The previous step may take some time as it will build the driver locally on target. After it completes verify that the drivers are installed correctly using: *Ismod*

lsmod	
d773@d773-deskt	op:~/Desktop/70773 Linux test tools\$ lsmod grep xocl
xocl	2220032 0
libcrc32c	12288 2 xclmgmt,xocl
drm	765952 15 gpu_sched,drm_kms_helper,drm_suballoc_helper,xocl,drm_display_helper,drm_buddy,amdgpu,drm_ttm_helper,ttm,amdx<
d773@d773-deskt	op:-/Desktop/7D773 Linux test tools\$ lsmod grep xclmgmt
xclmgmt	1294336 0
libcrc32c	12288 2 xclmgmt,xocl

- 5. Install the Embedded+ VE2302 "base" device package
 - a Get the latest base package from

https://www.xilinx.com/member/forms/download/xef.html?filename=xrt-emb-plus-ve2302base 0.5.deb

b Move package to the Embedded+ platform.

c Install with:

Install VE2302 base design files

sudo dpkg -i xrt-emb-plus-ve2302-base_0.5.deb

6. Install the Embedded+ VE2302 XRT platform test bitstream packages

a Get the latest test bitstream packages from:

xrt-verify-test-ve2302_0.5.deb: <u>https://www.xilinx.com/member/forms/download/xef.html?filename=xrt-verify-test-ve2302_0.5.deb</u>

xrt-bandwidth-dma-test-ve2302_0.5.deb

https://www.xilinx.com/member/forms/download/xef.html?filename=xrt-bandwidth-dmatest-ve2302 0.5.deb

xrt-aie-test-ve2302_0.5.deb

https://www.xilinx.com/member/forms/download/xef.html?filename=xrt-aie-testve2302_0.5.deb

- b Move the packages to the Embedded+ platform.
- c Install with:

Install XRT test bitstreams

sudo dpkg -i xrt-verify-test-ve2302_0.5.deb sudo dpkg -i xrt-bandwidth-dma-test-ve2302_0.5.deb sudo dpkg -i xrt-aie-test-ve2302_0.5.deb

7. Install the Versal APU SW package

- a Get the latest APU SW package from: <u>https://www.xilinx.com/member/forms/download/xef.html?filename=xrt-apu-linux-ve2302_0.5.deb</u>
- b Move the package to the Embedded+ platform.
- c Install with:

Install Versal APU SW

sudo dpkg -i xrt-apu-linux-ve2302_0.5.deb

8. Reboot the system

On-target Self Test

The following are self-test that the user can run to test that the Versal and x86 host are set-up and configured correctly.

PCIe Connectivity

Use *lspci* to inspect if Versal device is present on PCIe bus.

lspci	
	<pre>73-desktop:~/Desktop/7D773 Linux test tools\$ lspci -vd 10ee: Processing accelerators: Xilinx Corporation Device 5700 Subsystem: Xilinx Corporation Device 000e Flags: bus master, fast devsel, latency 0, IRQ 67, IOMMU group 9 Memory at 1fe0000000 (64-bit, prefetchable) [size=256M] Memory at 1ff8040000 (64-bit, prefetchable) [size=256K] Capabilities: <access denied=""> Kernel driver in use: xclmgmt Kernel modules: xclmgmt</access></pre>
01:00.1	Processing accelerators: Xilinx Corporation Device 5701 Subsystem: Xilinx Corporation Device 000e Flags: bus master, fast devsel, latency 0, IRQ 67, IOMMU group 10 Memory at 1ff8000000 (64-bit, prefetchable) [size=256K] Memory at 1ff0000000 (64-bit, prefetchable) [size=128M] Capabilities: <access denied=""> Kernel driver in use: xocl Kernel modules: xocl</access>

XRT Tests

The XRT "validate" tests are a set of PL/AIE design used to exercise basic functionality of the system. They have been installed with xrt*test*.deb packages.

Source the XRT tools:

Source XRT	
source /opt/xilinx/xrt/setup.sh	

Now the system is set up to run tests via xbutil command: verify, dma, mem-bw and aie. Instructions in following sections:

XRT Platform Inspection

Use XRT xbmgmt to see platform information.

XRT Platform	Inspection
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xbmgmt examine

System Configuratio	D	
OS Name	: Linux	
Release		
Version	: #41~22.04.2-Ubuntu SMP PREEMPT DYNA	AMIC Mon Jun 3 11:32:55 UTC 2
Machine	: x86 64	
CPU Cores		
Memory	: 5853 MB	
Distribution	: Ubuntu 22.04.4 LTS	
GLIBC	: 2.35	
Model		
BIOS vendor	: American Megatrends International,	LLC.
BIOS version		
(RT		
Version	: 2.17.326	
Branch	: 2024.1	
Hash	: 856be14f8ad700619aa836244352b52d201	f082a5
Hash Date	: 2024-06-10 01:22:20	
XOCL	: 2.17.326, 856be14f8ad700619aa836244	4352b52d20f082a5
XCLMGMT	: 2.17.326, 856be14f8ad700619aa836244	4352b52d20f082a5
Firmware Version	: N/A	
evices present		
BDF :	Shell Logic UUID	Device ID Device Ready*
	emb-plus 00000000-0000-0000-0000-000079[

Verify Test

The "Verify" test is a simple "hello world" application for testing core ability to download a user kernel captured as an xclbin and have an expected data transfer read back from that kernel "Hello World".

Run the test: Verify Test	
xbutil validate -r verify -dverbose	
Expected output:	

Verify test results Validation completed Verify Test Verbose: Enabling Verbosity Validate Device : [0000:01:00.1] Platform : emb-plus SC Version : 0.0.0 Platform ID : 00000000-0000-0000-0000-000079DB078F Test 1 [0000:01:00.1] : verify : Run 'Hello World' kernel test Description : [PASSED] Test Status -----

DMA Test

The "DMA" test is a simple DMA test that transfer data between Versal and Ryzen using DMA on Versal.

Run the test:

DMA test	
xbutil validate -r dma -dverbose	

Expected output:

DMA test results	
Verbose: Enabling Verbo	sity
Validate Device	: [0000:01:00.1]
Platform	: emb-plus
SC Version	: 0.0.0
Platform ID	: 00000000-0000-0000-0000-000079DB078F
<pre>st 1 [0000:01:00.1]</pre>	: dma
Description	: Run dma test
Details	: Buffer size - '16 MB' Memory Tag - 'MC_NOC'
	Host -> PCIe -> FPGA write bandwidth = 2704.1 MB/s Host <- PCIe <- FPGA read bandwidth = 3504.2 MB/s
Test Status	: [PASSED]

Bandwidth Test

The "bandwidth" test runs a limited bandwidth test on DDR memory and PCIe data transfers.

Run the test:

Bandwidth test

xbutil validate -r mem-bw -d --verbose

Expected output:

Bandwidth test results	
Validation completed	
Bandwith Test	
Verbose: Enabling Verbo	osity
Validate Device	: [0000:01:00.1]
Platform	: emb-plus
SC Version	: 0.0.0
Platform ID	: 00000000-0000-0000-000079DB078F
Test 1 [0000:01:00.1]	: mem-bw
Description	: Run 'bandwidth kernel' and check the throughput
Details	: Throughput (Type: DDR) (Bank count: 1) : 19002.7 MB/s Throughput of Memory Tag: MC NOC : 19002.7 MB/s
Test Status	: [PASSED]

AIE Test

The "aie" test runs a AIE tile functionality test.

Run the test:

AIE test xbutil validate -r aie -d --verbose

Expected output:

AIE test results	
Validation completed	
Verbose: Enabling Verbos	sitv
Validate Device Platform SC Version Platform ID	: [0000:01:00.1] : emb-plus : 0.0.0 : 00000000-0000-0000-000079DB078F
Test 1 [0000:01:00.1] Description Test Status	: aie : Run AIE PL test : [PASSED]

Debug Tools – Versal Serial Console

The Versal serial console is connected to the Ryzen device on the motherboard. Therefore user can access the uart outputs from Ryzen. In Ubuntu, first download picocom:

Install picocom

sudo apt-get install picocom

Then user can access the com ports on commandline from Ubuntu:

Connect to APU serial output:

sudo picocom -b 115200 /dev/ttyUSB1

Connect to PLM/RPU serial output:

sudo picocom -b 115200 /dev/ttyUSB2

FPGA(Xilinx) F/W Update

The VPR-4616-MB and VPR-4616-SYS are both shipped with OSPI image. You can check their version with "xbmgmt examine" command. A UUID of 00000000-0000-0000-0000-000079DB078F corresponds to embplus-ospi-emb-plus-ve2302-20240620051522.bin (0.5 release). Upgrading OSPI is necessary if the UUID does not match the release.

Software requirements

1. Vivado Installed

2. FPGA(Xilinx) F/W: Versal OSPI image file (*.bin) and PDI file (*.pdi), which can be downloaded from https://www.sapphiretech.com/en/commercial/edge-plus-vpr_4616#Download

PDI = Programmable Device Image

The boot image for Versal devices is called a PDI, which is an AMD file format processed by the PLM as part of the boot process or partial configuration process. The PDI data is specific to the design requirements. The boot image for Versal devices typically involves binaries used to boot and configure the platform. It is stored in OSPI flash.

Update Instruction:

Install Vivadolab

- 1. Install Vivado_lab 2023.2
 - a Download Vivado_lab for Linux from <u>https://www.xilinx.com/support/download/index.html/content/xilinx/en/downloadNav/viva</u> <u>do-design-tools/2023-2.html</u>, Xilinx instructions can be found in UG973 (<u>https://docs.amd.com/r/en-US/ug973-vivado-release-notes-install-license</u>)
 - b Extract the downloaded file. In the folder, give executable permission to installLibs.sh and xsetup and then execute:

chmod +x installLibs.sh
sudo ./installLibs.sh
chmod +x xsetup
sudo ./xsetup
(if any libraries are missing – install them manually, follow GUI to finish installing Vivado_lab)
cd \${vivado_install_dir}/data/xicom/cable_drivers/lin64/install_script/
install_drivers/
sudo ./install_drivers
sudo reboot now

c To launch Vivado_lab:

source \$(vivado_install_dir)/settings64.sh
vivado_lab

Note: \$(vivado_install_dir) is /tools/Xilinx/Vivado_Lab/2023.2 by default

Open Vivado

Vivado 2023.2 Bie Row Tools Window Help Q: Osick/Access Bie Row Tools Window	÷.α.χ.
AMDA Vivado ML Edition	
Quick Start Create Project > Open Project >	Recent Projects 201 esc et 202 esc et Constructionsamele(20) microsphal20), microsphal201, microsp
TelConsole Q X ⊕ II II II III III III feete_get x Type + 702 command hace	7 - 0 5 X
📰 🔎 Type here to search	国 86年 Parthy sunny へ Gr do Go (200 月)

1. Click Open Hardware Manager

Quick Start Create Project > Open Project > Open Example Project >	
Tasks Manage IP > Open Hardware Manager > Vivado Store >	
Learning Center Documentation and Tutorials > Quick Take Videos > What's New in 2023.2 >	

2.	Click Open target and select Auto Connect
	Eile Edit Tools Reports Window Layout View Help Q- Quick Access Image:
	HARDWARE MANAGER - unconnected
	No hardware t Den target
	Hardware Q Z P P P P P P P P P
	Properties ? _ □ □ ×

 Move the cursor to xcve2302_1, press the right button of the mouse, and select Add Configuration Memory Device

Eile Edit Too	ls Reports Wind	ow Layout	View Help	HOK ACCESS	
B 1		16 16 X	Dashboard +		
HARDWARE MANAGE	R - localhost/xilinx_tcf/	(Ilinx/52H2405000	002A		
🕧 There are no seria	al I/O links. Auto-detect	links Create links	s i		
Hardware	3	- 🗆 🖾 ×	DDRMC - DDRMC_1		
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Name		Status	Status Status P	Registers	
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O xcve22n Sys O Sys O V Sys O V Sys O V Sys O V Sys C C Hardware Device	Hardware Device Program Device Venity Device Reitresh Device Show Bus Plot	500 (19 20 COV) (11		GOOD tus: Running No errors detected during calibration.	
	Boot from Config	ration Memory De	vice.		
• xcve2302_1	Export to Spreads	heet_			
Name:	xcve2302_1	0	Stage		Status
Part	xcve2302		CAL_STAGE.01_F	_PHY_BISC	Pass
ID code	14CC8093		CAL_STAGE.02_F0	7 17. ·	Pass
				_LPDDR4_CS_CA_TRAIN	Pass
IR length:	6		CAL_STAGE.04_F0	행동 중 장 동 정 옷 옷 공	Pass
Status:	Programmed		CAL_STAGE.05_F0	_WRITE_LEVELING	Pass

4. Select Cfgmem-ospi-x8-single then click OK

Add Configuratio	on Memory Device							
Choose a cor	figuration memory	/ part.						
Device: () xcve23	02_1							
Manufacturer	All		<u>_</u>		Type	All		~
Density (<u>M</u> b)	All		~		Width	AII		~
			Reset A	II Filters				
Select Configuration	Memory Part							
Select Configuration	Memory Part							
	Memory Part	Part	Manufact	Alias	Family	Type	Density (Width
Search: Q- Name	Memory Part	Part cfgmem	Manufact	Alias	Family	Type ospi	Density (2048	Width x8-dual_s
Search: Q- Name	-x8-dual_stacked		Manufact	Alias	Family			
Search: Q- Name Image: Search	-x8-dual_stacked	cfgmem	Manufact	Alias	Family	ospi	2048	x8-dual_s
Search: Q- Name Image: Search	-x8-dual_stacked -x8-single -x1-dual_stacked	cfgmem cfgmem	Manufact	Alias	Family	ospi ospi	2048 2048	x8-dual_s x8-single
Search: Q- Name I cfgmem-ospi Cfgmem-ospi Cfgmem-qspi Cfgmem-qspi	-x8-dual_stacked -x8-single -x1-dual_stacked	cfgmem cfgmem cfgmem	Manufact	Alias	Family	ospi ospi qspi	2048 2048 2048	x8-dual_s x8-single x1-dual_s
Search: Q- Name I cfgmem-ospi Cfgmem-ospi Cfgmem-qspi Cfgmem-qspi	-x8-dual_stacked -x8-single -x1-dual_stacked -x1-single -x2-dual_stacked	cfgmem cfgmem cfgmem cfgmem	Manufact	Alias	Family	ospi ospi qspi qspi	2048 2048 2048 2048 2048	x8-dual_s x8-single x1-dual_s x1-single
Search: Q- Name Grigmem-ospi Grigmem-ospi Grigmem-ospi Grigmem-ospi Grigmem-ospi Grigmem-ospi Grigmem-ospi Grigmem-ospi Grigmem-ospi Grigmem-ospi Grigmem-ospi	-x8-dual_stacked -x8-single -x1-dual_stacked -x1-single -x2-dual_stacked	cfgmem cfgmem cfgmem cfgmem cfgmem	Manufact	Alias	Family	ospi ospi qspi qspi qspi	2048 2048 2048 2048 2048 2048	x8-dual_s x8-single x1-dual_s x1-single x2-dual_s
Search: Q- Name Grigmem-ospi Grigmem-ospi Grigmem-ospi Grigmem-ospi Grigmem-ospi Grigmem-ospi Grigmem-ospi Grigmem-ospi Grigmem-ospi Grigmem-ospi Grigmem-ospi	-x8-dual_stacked -x8-single -x1-dual_stacked -x1-single -x2-dual_stacked -x2-single -x4-dual_stacked	cfgmem cfgmem cfgmem cfgmem cfgmem cfgmem	Manufact	Alias	Family	ospi ospi qspi qspi qspi qspi	2048 2048 2048 2048 2048 2048 2048 2048	x8-dual_s x8-single x1-dual_s x1-single x2-dual_s x2-single
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5. Selected file path (BIN) of Configuration file

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emory Device:	cfgmem-ospi-x8-single			
onfiguration file:	C:/Users/ii/Desktop/7d773/emb-	plus-ospi-emb-plus-ve23	02-20240620051522.bin	ø
<u>i</u> n Offset:	0			_
itialization <u>P</u> DI:	C:/Users/ii/Desktop/7d773/ve230	2_pcie_qdma_base_0.5	pdi	© ···
ogram Operatio	ons			
Address Rang	e: Configuration File Only	~		
✓ Erase				
Blank Che	ck			
✓ Program				
Verify				

6. Select emb-plus-ospi-emb-plus-ve2302-20240620051522.bin and click OK

Specify File	le		×
Look in:	7d773	✓ ★☆무±回▷×C ■	:Ξ
tatu 👫 emb-plu:	Is-ospi-emb-plus-ve2302-20240620051522.bin	Recent Directories	
IS: Ve2302_	pue_quina_base_b.b.pui	C:/Users/ii/Desktop/7d773	~
g St		File Preview	
		File: emb-plus-ospi-emb-plus-ve2302-20240620051522.bin Directory: C//Users/ii/Desktop/7d773 Created: Saturday 07/27/24 04:28 AM Accessed: Yesterday at 16:22 PM Modified: Yesterday at 09:47 AM Size: 127 9 MB Type: Bitstream file Owner: DESKTOP-GC2N31Nii	
1_F			
2_F			
3_F 4_F			
5_F			
6_F			
7_F 8_F File <u>n</u> ame:	emb-plus-ospi-emb-plus-ve2302-20240620051522.bin		
Files of type:	Configuration Files (.mcs, bin, pdi)		~
		Салс	el

7. Selected file path (PDI) of Initialization PDI

		a
elect a configuratio	n file and set programming options.	
Memory Device:	🛈 cfgmem-ospi-x8-single \cdots	
Configuration file:	C:/Users/ii/Desktop/7d773/emb-plus-ospi-emb-plus-ve2302-20240620051522.bin	
B <u>i</u> n Offset:	0	
Initialization <u>P</u> DI:	C:/Users/ii/Desktop/7d773/ve2302_pcie_qdma_base_0.5.pdi	
Program Operatio	ons	
Address Rang	e: Configuration File Only	
🗹 <u>E</u> rase		
Blank Che	ck	
✓ Program		
✓ Verify		

8. Select ve2302_pcie_qdma_base_0.5.pdi and click OK, Programming starts after OK is clicked.

Specify Pdi	File	
Look in:	74773	✓ I A Q I A R X C III
↓ ^{ll} ve2302_p	cie_qdma_base_0.5.pdi	Recent Directories
		C/Users/li/Desktop/7d773
		File Preview
		File: ve2302_pde_qdma_base_0.5.pdi Directory: C:UserMi/Desktop/7173 Created: Saturday 07/27/24 04:28 AM Accessed: Yesterday at 10:21 PM Modified: Yesterday at 09:47 AM Size: 4.2 MB Type: Bitstream file Owner: DESKTOP-GC2N31Ni
ile <u>n</u> ame:	ve2302_pcie_qdma_base_0.5.pdi	
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9. Programming...(Approximate programming time is 50 mins)

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		E Default and
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There are no debug cores. Program device: Reflectin device		
Hardware ? _ D D X		
Q X & 0 > > = 0		
Name Statum		
I localhost(1) Connected		
✓ ■ # xitri_td00inw52L2335000014A Open		
@ am_dap_0(0) N/A		
Ø stve2302_1(1) Programmed		
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10. Programmed OK

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ARDWARE MANAGER - Incalhosti	line_35700nv52L23350003144		1
There are no debug cores. Prop	ram device. Refresh device		
Hardware	?_08×		
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 III # xilms_td00lms521,2335 	030014A Open		
(1) 0_qeb_ms @	N/A		
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- 11. Power off the system, unplug the power connector.
- 12. Plug in the power connector and turn on the system.