

# LynxOS-178 Xilinx Zynq Ultrascale+ MPSoC Board Support Guide

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LynxOS-178 DOC-2212-00



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# Preface

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## Typographical Conventions

The typefaces used in this manual, summarized below, emphasize important concepts. All references to filenames and commands are case-sensitive and should be typed accurately.

### Kind of Text

Body text; *italicized* for emphasis, new terms, and book titles

### Examples

Refer to the *LynxOS-178 ZCU102 Board Support Guide*

Environment variables, filenames, functions, methods, options, parameter names, path names, commands, and computer data

```
ls -l myprog.c /dev/null
```

Commands that need to be highlighted within body text, or commands that must be typed as is by the user are **bolded**.

```
login: myname  
# cd /usr/home
```

Text that represents a variable, such as a filename or a value that must be entered by the user, is *italicized*.

```
cat <filename>  
mv <file1> <file2>
```

Blocks of text that appear on the display screen after entering instructions or commands

```
Loading file  
/tftpboot/shell.kdi into  
0x4000
```

```
.....
```

```
File loaded. Size is 1314816
```

```
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Technologies, Inc. All rights  
reserved.
```

Keyboard options, button names, and menu sequences

**Enter, Ctrl-C**

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## Technical Support

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### How to Submit a Support Request

When you are ready to submit a support request, please include *all* of the following information:

- First name, last name, your job title
- Phone number, e-mail address
- Company name, address
- Product version number
- Target platform (for example, PowerPC)
- Board Support Package (BSP), Current Service Pack Revision, Development Host OS version
- Detailed description of the problem that you are experiencing:
- Is there a requirement for a US Citizen or Green Card holder to work on this issue?
- Priority of the problem - Critical, High, Medium, or Low?

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## Where to Submit a Support Request

Support, Europe	tech_europe@lynx.com +33 1 30 85 93 96
Support, worldwide except Europe	support@lynx.com +1 800-327-5969 or +1 408-979-3940 +81 33 449 3131 [for Japan]
Training and Courses	USA: training-usa@lynx.com Europe: training-europe@lynx.com USA: +1 408- 979-4353 Europe: +33 1 30 85 06 00

## CHAPTER 1 *Overview*

This guide provides important information regarding the LynxOS-178 Board Support Package (BSP) for the Xilinx Zynq Ultrascale+ MPSoC evaluation board from Xilinx.

In this document, the Xilinx Zynq Ultrascale+ MPSoC evaluation board will be referred to as either the "ZCU102 board" or the "target board".

The BSP includes target board specific initialization and device drivers. The remainder of the standard LynxOS-178 distribution, the open development environment (ODE) files, the cross-development kit (CDK) tools, and the associated libraries, debuggers, binaries and the LynxOS-178 Kernel are shared with other BSPs.

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### Features Overview

This section describes features specific to this BSP.

Refer to the *LynxOS-178 Installation Guide* and *LynxOS-178 User's Guide* for additional information about LynxOS-178 development and production modes.

#### Ethernet Driver

The Ethernet driver is developed for the TCP/IP stack that is available in the LynxOS-178 development mode and provides the following hardware features:

- Supported link speeds are 10/100/1000 Mbps
- Auto-negotiation mode

The BSP is also compatible with the Lynx Certifiable Stack v2.2 network stack and NIC driver. For the most recent information, please refer to either the "*Lynx Certifiable Stack v2.2 User's Guide*".

#### Serial Drivers

Two UART 16550 compatible serial drivers are implemented:

- The tty driver for development mode
- The rs232 driver for production mode

Both serial drivers provide the following features:

- RS-232 ports
- Read/write operations from/to the serial port
- An `ioctl()` interface for controlling device properties

#### USB Driver

One USB 3.0 / 2.0 port is supported by the supplied USB driver.

#### PCI Support

The BSP supports 4-Lane PCIe bus available on Target Board. The BSP uses the DRM subsystem to access the PCI devices.

### Supported Hardware

Table 1-1 describes the hardware supported with this release.

**Table 1-1: Supported Hardware for the Target Board**

Model	Description
ZCU102	<ul style="list-style-type: none"> <li>• Zynq® UltraScale+™ MPSoC HW-Z1-ZCU102 REV 1.1 or above</li> <li>• One Gigabit Ethernet Port</li> <li>• Two RS-232 Serial Ports</li> <li>• One PCIe bus</li> <li>• One USB 3.0 / 2.0 Port</li> </ul>

---

## Supported Cross-Development Configurations

A cross-development environment consists of a cross-development host running on a platform that is different from the intended target board.

LynxOS-178 kernel downloadable images (KDIs) and their associated applications are built with the LynxOS-178 cross-development kit on the cross- development host and then downloaded onto the target board.

Refer to the LynxOS-178 Release Notes for Supported Cross-Development Configurations.



## CHAPTER 2 *Installing LynxOS-178 on the Target Board*

This chapter details the installation and configuration instructions for the BSP. To install LynxOS-178 on the target board, the following steps shall be done:

- Installing the cross-development environment
- Building a KDI for the target board
- Target board setup
- Configuring the TFTP Server
- Downloading and booting a KDI over a network

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### Installing the Cross-Development Environment

The Cross-Development system installation instructions are provided in the *LynxOS-178 Installation Guide* to install LynxOS-178 ARM Development Kit for ZCU102 on cross development host system.

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### Building a KDI for the Target Board

After the LynxOS-178 ARM Development Kit for ZCU102 installed, it contains a template that a user can use to build a KDI for execution on the target board.

**NOTE:** to run KDIs on the bare metal ZCU102 targets, the `sys/bsp.zcu102/bsp_tests.cfg` file shall be updated. Specifically, the `ELF` variable shall be set to the `true` value:

```
ELF=true
```

The following table lists the KDI templates that are provided with LynxOS-178. Each template provides pre-defined specification files that can be used as a starting point to customize to the needs for each user application.

**Table 2-1: KDI Template**

arinc653	This KDI contains ARINC 653 applications demonstrating the configuration and use of ARINC 653 queuing ports.
developer	This KDI contains development and networking utilities that provide a minimal configuration for development.

The *LynxOS-178 User's Guide* provides the detailed description on configuring, building, and using LynxOS-178 KDIs.

To boot LynxOS-178 on the target board, users need to set up a LynxOS-178 cross-development environment on a cross-development host and use this environment to create a LynxOS-178 KDI built for the target board. This image is then transferred to the target board via TFTP.

### ARINC653 KDI

The `arinc653` demo contains ARINC 653 applications demonstrating the configuration and use of ARINC 653 queuing ports for inter-VM communication. This demo creates two VMs running a producer/consumer application using ARINC 653 queuing ports to transmit data between the two processes running in different VMs.

## Developer KDI

By default, the `developer` demo contains development and networking utilities that provide a minimal configuration for development. The `developer` demo can be used to work with the LynxOS-178 Development Tools, specifically:

- Luminosity
- SpyKer

## Sample KDI

To create a sample KDI, perform the following steps:

1. Source the `SETUP.bash` script in the root of the source tree:

```
$ cd <installation_dir>
$ . SETUP.bash
```

2. Change to the BSP directory:

```
# cd $ENV_PREFIX/sys/bsp.zcu102
```

3. TCP/IP is enabled by default. To disable TCP/IP make sure that the lines for TCP/IP in the `config.tbl` file read as follows:

```
ifdef("VMOS_DEV", "
#I:hbtcpip.cfg
#I:gem.cfg
")
```

4. NFS is enabled by default. To disable NFS make sure that the lines for NFS in the `config.tbl` file read as follows:

```
ifdef("VMOS_DEV", "
#I:nfs.cfg
")
```

Note that NFS requires TCP/IP to function. If TCP/IP and NFS are disabled, users may remove the networking binaries to generate a smaller KDI. This can be done by commenting out unnecessary binaries in the `$ENV_PREFIX/sys/bsp.zcu102/lynxos-178.spec.in` file.

Users may comment out the following lines:

```
file=ifconfig source=$(ENV_PREFIX)/bin/ifconfig owner=0 group=0 mode=-r-xr-xr-x
file=ping source=$(ENV_PREFIX)/bin/ping owner=0 group=0 mode=-r-xr-xr-x
file=rcp source=$(ENV_PREFIX)/bin/rcp owner=0 group=0 mode=-r-xr-xr-x
file=login source=$(ENV_PREFIX)/bin/login owner=0 group=0 mode=-r-xr-xr-x
file=route source=$(ENV_PREFIX)/bin/route owner=0 group=0 mode=-r-xr-xr-x
file=rlogin source=$(ENV_PREFIX)/bin/rlogin owner=0 group=0 mode=-r-xr-xr-x
file=rc source=$(ENV_PREFIX)/bin/rc owner=0 group=0 mode=-r-xr-xr-x
file=hosts source=$(ENV_PREFIX)/etc/hosts owner=0 group=0 mode=-rw-r--r-- file=protocols
source=$(ENV_PREFIX)/etc/protocols owner=0 group=0 mode=-rw-r--r--
file=services source=$(ENV_PREFIX)/etc/services owner=0 group=0 mode=-rw-r--r--
file=inetd.conf source=$(ENV_PREFIX)/etc/inetd.conf owner=0 group=0 mode=-rw-r--r--
file=shells source=$(ENV_PREFIX)/etc/shells owner=0 group=0 mode=-rw-r--r--
file=passwd source=$(ENV_PREFIX)/etc/passwd owner=0 group=0 mode=-rw-r--r--
file=resolver.conf source=$(ENV_PREFIX)/etc/resolv.conf owner=0 group=0 mode=-rw-r--r--
file=unfsio source=$(ENV_PREFIX)/net/unfsio owner=0 group=0 mode=-r-xr-xr-x
file=irshd source=$(ENV_PREFIX)/net/irshd owner=0 group=0 mode=-r-xr-xr-x
file=rshd source=$(ENV_PREFIX)/net/rshd owner=0 group=0 mode=-r-xr-xr-x
file=rlogind source=$(ENV_PREFIX)/net/rlogind owner=0 group=0 mode=-r-xr-xr-x
file=telnetd source=$(ENV_PREFIX)/net/telnetd owner=0 group=0 mode=-r-xr-xr-x
file=ftpd source=$(ENV_PREFIX)/net/ftpd owner=0 group=0 mode=-r-xr-xr-x
file=inetd source=$(ENV_PREFIX)/net/inetd owner=0 group=0 mode=-r-xr-xr-x
file=rc.network source=$(ENV_PREFIX)/net/rc.network owner=0 group=0 mode=-r-xr-xr-x
```

5. Rebuild the Lynx OS-178 Development Kernel and KDI:

```
# make kdi
```

The resulting KDI will be located in this directory and will be named `lynxos-178.kdi`.

---

## Setting up the Target Board

Make sure that the hardware is properly set up by following the board suppliers' instructions.

1. Set the switches for SD card boot as described, for example, at the bottom of this page [<http://www.wiki.xilinx.com/Zynq+UltraScale+MPSoc+Base+TRD+2017.4>]. If you need the USB controller to operate in host mode rather than endpoint mode, the same page has instructions for setting the jumpers accordingly as well

2. Install Xilinx® Software Release 2018.3 found at Xilinx Wiki [<http://www.wiki.xilinx.com/Zynq+Releases>] to an SD card using the procedure described in that document. This should enable the U-Boot bootloader on the board
3. Install Silicon Labs CP2108 USB-to-UART bridge driver on the host computer. Silicon Labs provides royalty-free Virtual COM Port (VCP) drivers for the host compute.
4. Attach a USB mini cable between the USB UART port on the target and the host computer..
5. Open a serial connection on the host computer to communicate with the target.
6. Configure the host computer's serial port with the following settings:
  - Data rate:115200 bps
  - Number of data bits: 8
  - Parity: None
  - Number of stop bits: 1
  - Flow control: Hardware/None
7. Power up the board/chassis. The board will boot up and show the following U-Boot console messages (press a key to stop the board from autobooting):

```
Xilinx Zynq MP First Stage Boot Loader
Release 2018.3   Dec  6 2018   - 10:05:31
NOTICE:  ATF running on XCZU9EG/silicon v4/RTL5.1 at 0xffffea000
NOTICE:  BL31: Secure code at 0x0
NOTICE:  BL31: Non secure code at 0x10080000
NOTICE:  BL31: v1.5 (release):xilinx-v2018.2-919-g08560c36
NOTICE:  BL31: Built : 10:12:22, Dec  6 2018
PMUFW:   v1.1

U-Boot 2018.01 (Dec 06 2018 - 10:00:41 +0000) Xilinx ZynqMP ZCU102 rev1.0

I2C:   ready
DRAM:  4 GiB
EL Level:          EL2
Chip ID:           zu9eg
MMC:   mmc@ff170000: 0 (SD)
SF: Detected n25q512a with page size 512 Bytes, erase size 128 KiB, total 128 MiB
In:     serial@ff000000
Out:    serial@ff000000
Err:    serial@ff000000
Model: ZynqMP ZCU102 Rev1.0
Board: Xilinx ZynqMP
Net:    ZYNQ GEM: ff0e0000, phyaddr c, interface rgmii-id

Warning: ethernet@ff0e0000 MAC addresses don't match:
Address in SRAM is      00:0a:35:04:e5:70
Address in environment is 00:0a:35:00:22:01
eth0: ethernet@ff0e0000
ZynqMP>
```

8. Set the target board firmware environment to specify target IP, TFTP and Gateway addresses and boot command:

```
ZynqMP> setenv ipaddr <target_ip_address>
ZynqMP> setenv serverip <tftpserver_ip_address>
ZynqMP> setenv gatewayip <gateway_ip_address>
ZynqMP> setenv bootcmd "tftpboot 1000000 <image_name>; bootelf -p"
```

where

```
<target_ip_address> is the IP address of the target board;
<tftpserver_ip_address> is the TFTP server IP address;
<gateway_ip_address> is the gateway IP address
<image_name> is the LynxOS-178 KDI image name
```

For example:

```
ZynqMP> setenv ipaddr 192.168.1.231
ZynqMP> setenv serverip 192.168.1.91
ZynqMP> setenv gatewayip 192.168.1.254
ZynqMP> setenv bootcmd "tftpboot 1000000 lynxos-178.kdi; bootelf -p"
```

9. Save the environment

```
ZynqMP> saveenv
```

10. Boot up the LynxOS-178 KDI image

```
ZynqMP> boot
```

## Configuring the TFTP Server

After LynxOS-178 has been installed on the cross-development system, TFTP must be configured to communicate with the target board.

While the cross-development host may be used as the TFTP server, this is not a requirement. Any system which supports TFTP can be used. Instructions for our supported cross-development hosts is provided below.

## Configuring Network Boot with TFTP on a Linux Host

To enable TFTP on Linux cross-development host systems, perform the following steps:

1. Create the `tftpboot` directory:

```
# cd /var/lib/
# mkdir tftpboot
# chmod 777 tftpboot
# chmod +t tftpboot
```

2. Enable TFTP by editing the `tftp` file:

```
# cd /etc/xinetd.d
# vi tftp
```

3. In the `disable` field, type `no` to enable TFTP. Change:

```
disable = yes
```

To:

```
disable = no
```

4. In the `server_args` field, type `/tftpboot`. A sample `tftp` file is shown below.

```
service tftp
{
    disable = no socket_type = dgram protocol = udp
    wait = yes user = root
    server = /usr/sbin/in.tftpd server_args = -s /tftpboot
}
```

5. Restart the `xinetd` services.

```
# cd /etc/rc.d/init.d
# ./xinetd restart
```

## Configuring Network Boot with TFTP on a Windows Host

Windows does not include a TFTP server in its distribution.

---

## Booting LynxOS-178 on the Target Board

A network is required to boot LynxOS-178 on the target board using the pre-installed U-boot firmware.

### Booting over the Network using U-boot

Perform the following steps to boot LynxOS-178 over the network:

1. From the cross-development host, copy the KDI image onto the appropriate TFTP Server.
2. On the target U-Boot console, issue the following command to boot the default



## CHAPTER 3 *Supported Device Drivers*

This chapter describes the supported device drivers that are included with the BSP.

---

### BSP Device Drivers

The BSP provides the target board device drivers listed in Table 3-1.

**Table 3-1: BSP Target Board-Specific Device Drivers**

Interface	Common or BSP Specific	Driver Subdirectory (\$ENV_PREFIX/sys/drivers/)	Configuration File (\$ENV_PREFIX/sys/cfg/)	Controllers and Devices Supported
RS232	common	rs232	rs232.cfg	RS232 Devices
Serial	common	tty	com.cfg	RS232 Devices
Gigabit Ethernet	BSP specific	if_gem	gem.cfg	Gigabit Ethernet Controllers
USB	BSP specific	usb	usb.cfg usb_xhci_ultrascale.cfg simusb.cfg	USB 3.0/2.0 Controllers
Mouse	common	mousemgr	mousemgr.cfg	Generic USB HID Mouse
Keyboard	common	kdbmgr	kdbmgr.cfg	Generic USB HID Keyboard
Terminal	common	tty	tty.cfg	Terminal Controller
Null	Common	null	null.cfg	Null Device
Memory	Common	mem	mem.cfg	Memory Device
PTY	Common	pty	pty.cfg	Pseudo TTY
Arinc653	Common	arinc653	arinc653.cfg	ARINC 653
Ramdisk	Common	rd	rd.cfg	Ram based file system
Health Monitor	Common	hm	hm.cfg	Health Monitor
VMOS	Common	vmos	vmos.cfg	VMOS pseudo driver
Host Bus TCP/IP	Common	hbtcip	hbtcip.cfg	Host Bus TCP/IP
NFS	Common	nfs	nfs.cfg	network file system

Other drivers may be included in the base LynxOS-178 product that are not applicable to this BSP and should be ignored.

Running “make” in an unsupported driver directory may cause unexpected results and is not recommended.

### Configuration

The `if_gem` network driver is installed by default in development mode. The ZCU102 BSP supports the `gem0` network interface. After booting the development mode KDI, use the `ifconfig` (and `route if`

needed) command(s) to enable networking on a specific interface.

```
bash# ifconfig <interface-name> <target_IP_address>up
```

Example:

```
bash# ifconfig gem0 192.168.1.231 up  
bash# route add default 192.168.1.254
```

## USB Driver Configuration

Perform the following steps:

1. Make sure the following USB configuration files are not commented out in the

`$ENV_PREFIX/sys/bsp.zcu102/config.tbl` file:

```
# USB device drivers  
I:usb.cfg  
I:usb_xhci_ultrascale.cfg  
I:simusb.cfg  
I:mousemgr.cfg  
I:kbdmgr.cfg
```

2. Build the KDI and boot it on the target board.

- 2.1. Create a partition on a USB device using the `mkpart` utility.

```
$ mkpart /dev/rsdusb.0
```

- 2.2. Create a file system on that partition using the `mkfs` utility.

```
$ mkfs -b 512 /dev/sdusb.0a
```

- 2.3. Create a mount point and mount the partition.

```
$ mkdir /tmp/mnt
```

```
$ mount /dev/sdusb.0a /tmp/mnt
```

## CHAPTER 4 *Xilinx Zynq Ultrascale+ MPSoc evaluation Target Board Testing*

The following hardware/software combination was tested:

Xilinx Zynq-UltraScale+ MPSoc

Part number: EK-U1-ZCU102-G

Revision: HW-Z1-ZCU102 REV 1.1 or above

Xilinx Zynq MP First Stage Boot Loader

Release 2018.3 Dec 6 2018 - 10:05:31

NOTICE: ATF running on XCZU9EG/silicon v4/RTL5.1 at 0xfffea000

U-Boot 2018.01 (Dec 06 2018 - 10:00:41 +0000) Xilinx ZynqMP ZCU102 rev1.0