MiniZed OTA OS Programming Customer Demo

Introduction

Utilizing the provided files in the downloaded package, demonstrate the building blocks of Over the Air (OTA) programming. Customers can use this process to enable the products they are working on to be field upgraded. It would be their responsibility to work out security, image validation, as well as other aspects of this becoming a commercially viable option. Due to the wide variety of overall solutions, this demo only provides for the basic building blocks which can be used for creating an end-to-end solution.

NOTE: Skip to the last page for the Quick Start style instructions used for executing this demonstration.

MiniZed Overview

The MiniZed™ Starter Kit from Avnet Electronics Marketing provides engineers with a complete system for prototyping and evaluating systems based on the Xilinx Zynq® 7Z000S device family.

MiniZed is a Zynq 7Z007S single-core development board. With the advent of the latest cost-optimized portfolio from Xilinx, this board targets entry-level Zynq developers with a low-cost prototyping platform. Please contact your local Avnet FAE for further details.

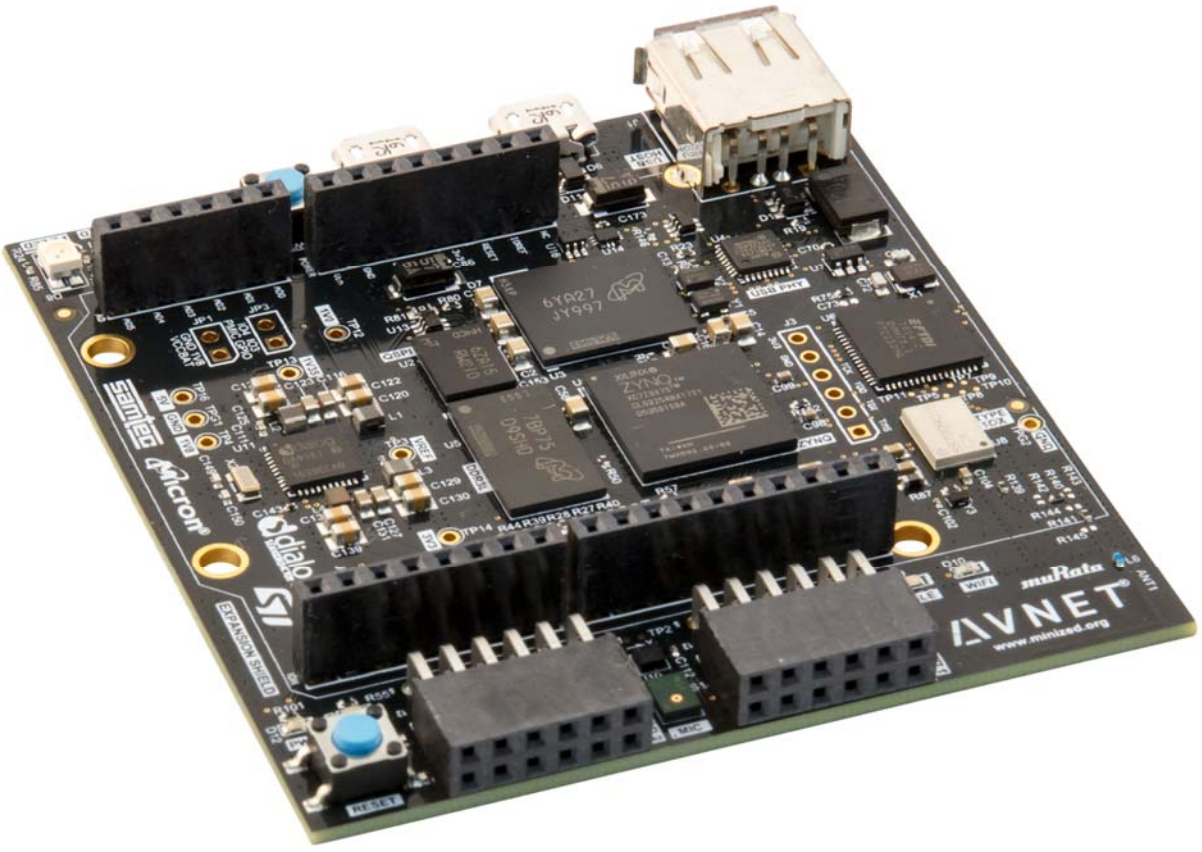


Figure 1 - MiniZed

Design Objectives

This MiniZed tutorial offers system developers an example of how to:

- Using Wi-Fi and a prebuilt system image, program a factory default MiniZed with a 2 stage process image showing the MiniZed booting from the provided EMMC
- Reset the MiniZed back to Flash-only-Boot, using traditional Vivado JTAG techniques

Experiment Setup

This demonstration builds upon the concepts and lab activities of the Avnet MiniZed Tutorials which cover the use of Xilinx Vivado Design Suite in creating/testing a basic Zynq 7Z7007S PetaLinux platform and running software applications. Please refer back to this reference material on the MiniZed community website for further information on how to configure the underlying MiniZed hardware platform.

You can find the Getting Started Guide, as well as more Avnet training materials, including the MiniZed Tutorials, on the MiniZed.org site
Navigate to www.MiniZed.org → Support → Training and Tutorials

For Reference Designs and MiniZed SPECIFIC Tutorials
Navigate to www.MiniZed.org → Reference Designs / Tutorials → MiniZed (Click the View button)

Example Design Requirements

Software

The software used to test this reference design is:

- Xilinx Vivado Design Suite 2017.1 (Free WebPACK license and download from Xilinx website)

Hardware

The hardware setup used to test this reference design includes:

- Lenovo ThinkPad T420 Laptop
    - Intel® Core i5-2540M CPU - 2.60 GHz
    - 4GB DDR3 Memory
- Stock Avnet MiniZed (AES-MINIZED-7Z007-G)
- 2 - USB cables (Type A to Micro-USB Type B)
- 1GB+ USB flash drive (Formatted Fat or Fat32)

Experiment: Setting Up For the Experiment

Refer to the following figure and perform the following steps to set up the boards used in this design:

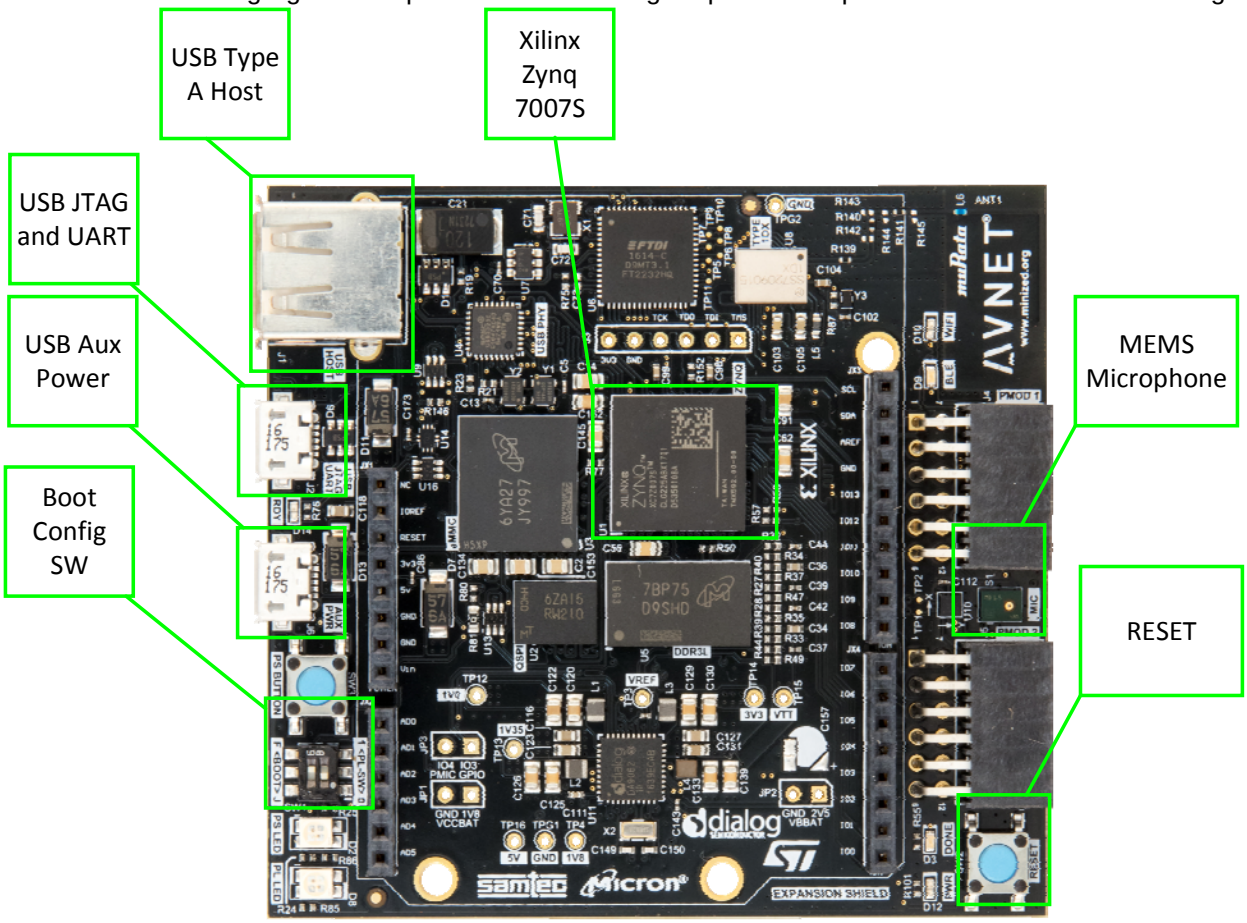


Figure 2 - MiniZed Experiment Connections

1. Insert your USB flash drive into your PC
2. Extract the archive zip file to the root of the drive, ex: f:\

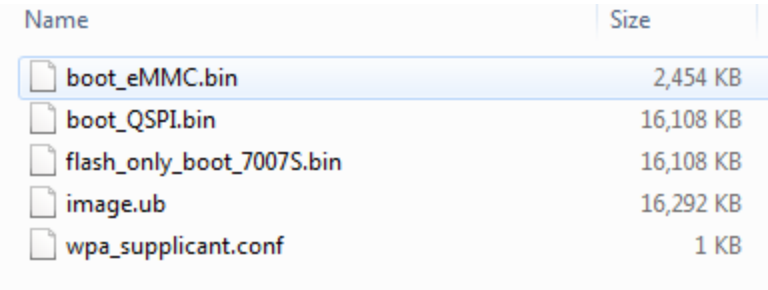


Figure 3 - Archive Contents

3. Provided in the archive are 5 files.

    a. boot_eMMC.bin – a small boot loader used to load the operating system from image.ub which needs to be located in eMMC memory

    b. boot_QSPI.bin – an entirely self-contained QSPI boot image. This image includes a reduced-size kernel image that is too small to include, for example, support for Bluetooth

    c. flash_only_boot_7007S.bin – binary used with traditional JTAG mechanisms to reset the MiniZed back to a Flash-only-Boot state

    d. image.ub – much larger container including more PetaLinux features such as the Bluetooth stack

    e. wpa_supplicant.conf – cross platform network configuration file typically used in a Linux environment to detail network selection, security as well as a number of other settings

4. Insert one USB cable into the MiniZed USB JTAG/UART MicroUSB connector.

5. Plug the other end into your PC, Windows 7 and later should detect and install drivers.

    a. In the rare circumstance that the drivers are not auto-installed, then you must manually install the driver for the FTDI FT2232H device. Visit the FTDI website and download the appropriate driver for your operating system.

    http://www.ftdichip.com/Drivers/VCP.htm

    b. Make sure the MiniZed is unplugged from the PC. Unzip and install the driver.

    c. Reboot your PC then plug in the MiniZed.

6. If this is the first time you have connected your MiniZed, locate the COM Port assigned.

    a. Right click on “My Computer” and choose Manage.

    b. From here, select Device Manager

    c. Under the Ports section, locate the USB Serial Port Assignment

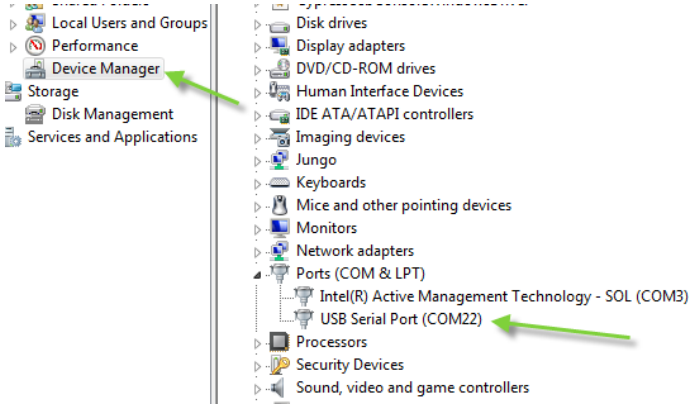


Figure 4 - Device Manager

7. Open a terminal program such as TeraTerm. Configure it to connect to the COM Port we found in the previous step using 115200/8/n/1/n as settings.

8. When the MiniZed is Flash-only-Boot, it contains an install of PetaLinux. You can see in Figure 5 many of the boot messages associated with this configuration.

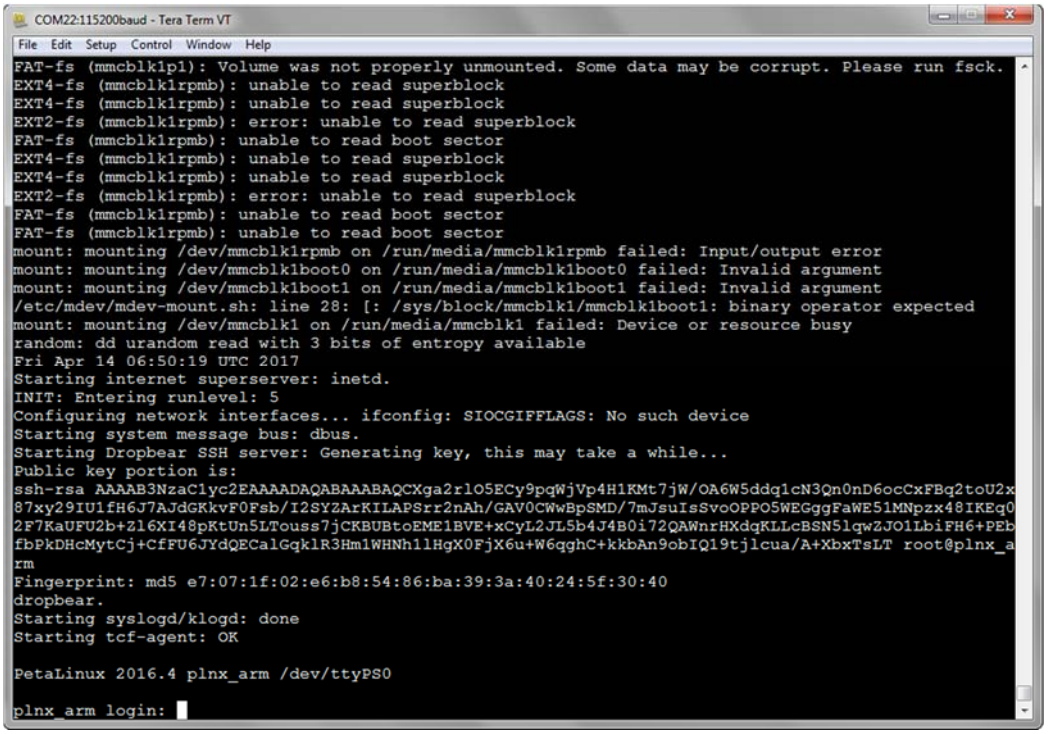


Figure 5 - Example TeraTerm Session

9. To see these messages, first configure the boot jumper. You can select between **F**LASH and **J**TAG booting. We want to ensure switch 1 is set towards the F or PL_Button.

    a. Note: From the Factory the switch's protective film should be removed and already set to F. If it is not, the switch will look similar to Figure 6.

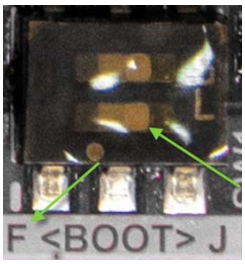


Figure 6 - Untouched Boot Switch

    b. If your MiniZed boot configuration switch is similar to the above, remove the protective film and slide switch 1 (indicated by the silkscreen DASH above the F) to be toggled to FLASH Booting (F).

10. At this point, leaving the terminal window open, push the RESET button as indicated by Figure 2.

Experiment 1: Program the 2-Stage Boot Image

The experiments in this tutorial are based upon the Avnet MiniZed Tutorials Lab Work.

1. Having already extracted the archive to the ROOT of the USB flash drive (see Figure 3), open the wpa_supplicant.conf file (Figure 7) in a Linux compliant text editor, such as Notepad++.

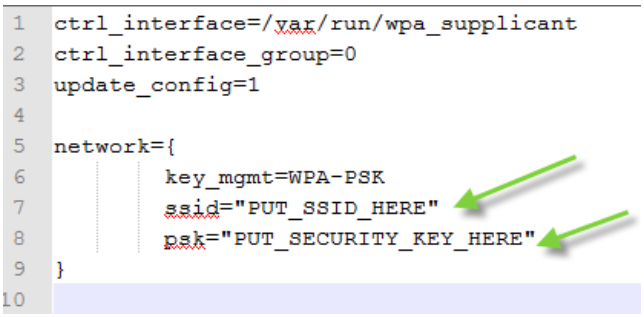


Figure 7 - Archived wpa_supplicant.conf

2. Insert your Wi-Fi Service Set IDentifier (SSID) and Pre Shared Key (PSK), leaving the quotation marks, then save this file!

3. Copy the flash_only_boot_7007S.bin to your computer's hard drive, for example to c:\avnet

    a. We will need this file later on. It is HIGHLY recommended to locate this on a STABLE location. If the JTAG process is interrupted before completing, the process would need to be started over in order to recover the Zynq 7007S back to a useable state

4. Having already booted up the MiniZed (Setting Up For the Experiment Step 7), login using the username/password of root/root

5. From here, we will identify the current boot image. As QSPI is limited in space, the factory PetaLinux image does NOT include the necessary drivers and software stacks involved in using the Murata Bluetooth hardware.

```
cd /usr/local/bin

ls -l
```

6. You should observe the terminal output from the MiniZed in the **terminal** window.

    a. Notice that there is a lack of a bt.sh configuration script. This is due to the Flash-only-Boot configuration booting directly from QPSI. We do not have enough space to include a fully featured PetaLinux install.

7. At this point we will want to prepare our MiniZed to connect to our Wi-Fi network. Looking at the files included in the archive (Figure 3), we can see that we will want to work with our modified wpa_supplicant.conf, image.ub, and boot_eMMC.bin.

8. Insert the USB flash drive, prepared using the steps above, into the MiniZed USB Host J1 slot.

9. Notice the terminal window does not indicate ANYTHING

10. Plug the second USB cable into the microUSB labeled Aux Power (Figure 2).

    a. As the USB Specification in some cases only allows for up to 500mA, the USB Host port is powered from the AUX connector. Without this connected, the USB flash drive will not be powered up. It will not register with the operating system.

11. Notice the terminal window output

```
usb 1-1: new high-speed USB device number 2 using ci_hdrc

usb-storage 1-1:1.0: USB Mass Storage device detected

scsi host0: usb-storage 1-1:1.0

scsi 0:0:0:0: Direct-Access     Kingston DT 101 G2       PMAP PQ: 0 ANSI:
0 CCS

sd 0:0:0:0: Attached scsi generic sg0 type 0

sd 0:0:0:0: [sda] 7669824 512-byte logical blocks: (3.93 GB/3.66 GiB)
```

12. This indicates that the PetaLinux install has successfully found the USB flash drive and mounted it to `/run/media/sda1`

13. At this point, navigate to the eMMC, clear any files that might be present and lastly navigate to the USB flash drive

```
cd /run/media/mmcblk1p1

rm *

cd /run/media/sda1

ls -l
```

14. Notice the files we placed on the USB flash drive are visible to our MiniZed

15. Copy the configuration to the MiniZed's eMMC and validate the file using the below commands

```
cp wpa_supplicant.conf ../mmcblk1p1/

cat ../mmcblk1p1/wpa_supplicant.conf
```

16. Observe our updated wpa_supplicant.conf is now on the MiniZed. At this point, the file is located in nonvolatile memory space and a reset will NOT wipe out our configuration

17. From here, navigate to the provided user scripts and view the provided wifi.sh file

```
cd /usr/local/bin/

cat wifi.sh
```

18. Validate that the script will overwrite wpa_supplicant.conf if it exists on eMMC.
    a. This means, this script will always check for a new configuration in the eMMC memory, if it exists, the DEFAULT wpa_supplicant.conf, located in volatile memory at each reboot, will be overwritten by our configuration file located in eMMC memory space
19. Execute the wifi.sh script and notice the WI-FI LED on the MiniZed lights, see Figure 2.

```
./wifi.sh
```

20. If your configuration is accurate you will see the MiniZed get an IP address and will have access to the Wi-Fi network (Figure 8)

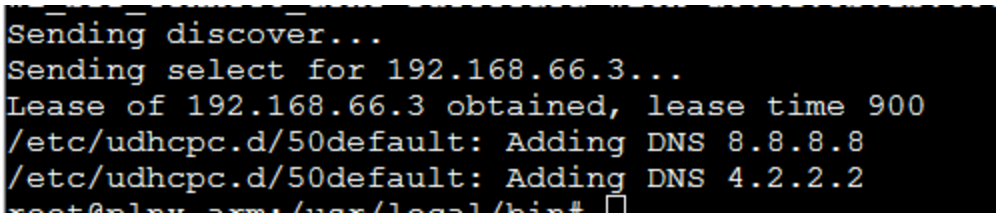


Figure 8 - Wi-Fi Assigned DHCP Configuration

21. Remove the USB flash drive from the MiniZed and insert it into your PC
22. The PetaLinux image contains an install of Dropbear SSH server. Using this, the remaining files will be copied to the MiniZed using an SSH client.
23. Using a PC with connectivity to the same network as the MiniZed, open a program such as WinSCP. Using the IP address provided in the above steps, connect to the MiniZed
    a. For details on this, please refer to the Getting Started Guide Located at MicroZed.org
24. Copy both the image.ub and boot_eMMC.bin to /run/media/mmcblk1p1/
25. Validate the files are located on the eMMC by executing the following commands in your terminal

```
cd /run/media/mmcblk1p1

ls -l
```

26. Now execute the flashcp program, which will take the binary files and properly insert them into the QSPI using the proper formatting

```
flashcp /run/media/mmcblk1p1/boot_eMMC.bin /dev/mtd0
```

27. As this is writing into QSPI, it can take a bit of time.
28. To ensure that we allow the operating system to properly clean up and unmount everything, instead of using the RESET button, execute the reboot command

```
reboot
```

29. After the MiniZed has finished rebooting, validate that we are in fact using the NEW image.
30. As before using root/root as your username and password. Then execute the below commands

```
cd /usr/local/bin/
ls -al
```

31. Observe this time, there is a bt.sh
32. Execute this file with./bt.sh and notice on the MiniZed the BLE Led lights, see Figure 2
33. Again, execute the wifi.sh through the use of ./wifi.sh, notice the MiniZed connects to the network again, as the wpa_supplicant.conf is located in the eMMC, programming the QSPI did not modify those files

Experiment 2: Reset to Flash-only-Boot

Now that the embedded target software has been setup and MiniZed is booted with Linux we can now step through a more traditional JTAG programming. As we will be bandwidth limited to the speed of our USB port, the user will observe the greatly increased time it takes to re-program the MiniZed

1. On the PC, open Xilinx Software Command Line Tool 2017.1.
    a. This is located Start → All Programs → Xilinx Design Tools → SDK 2017.1
2. After this has completed opening, navigate to the location where the flash_only_boot_7007S.bin was copied to. While you can execute this directly from the USB flash drive, it is recommended to run from a more reliable drive.
3. From here, execute the SDK command to JTAG the binary file into QSPI over the JTAG link.

```
cd c:/Avnet

exec program_flash -f flash_only_boot_7007S.bin -flash_type qspi_single
```

4. Observe the increased time programming takes, compared to copying the files over Wi-Fi and executing a local programming command
5. Once complete, you should observe a Flash Operation Successful message as indicated by Figure 9

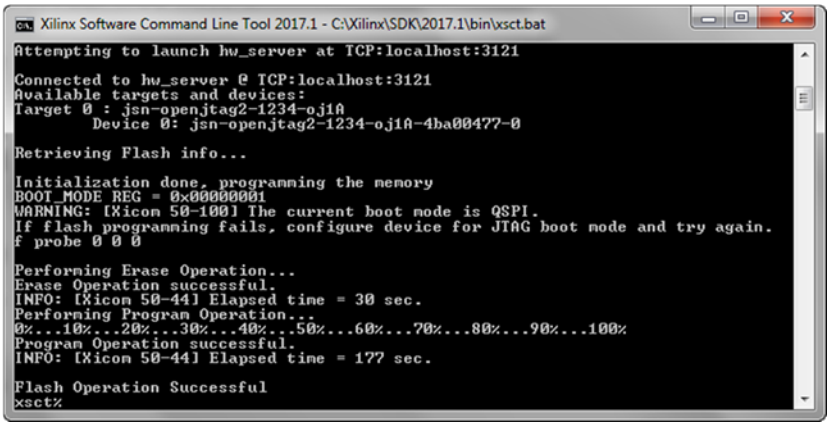


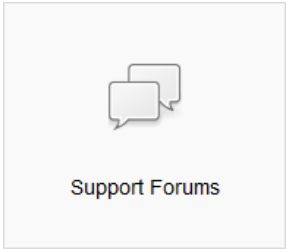
Figure 9 - JTAG Programming Successful

6. To validate this has been properly reprogrammed to Flash-only-Boot, repeat steps of 5 and 6 of Experiment 1. The lack of bt.sh will indicate that we have properly reset back to a Flash-only-Boot state.

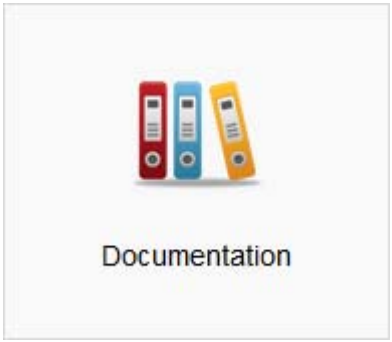
Appendix I: Getting Support

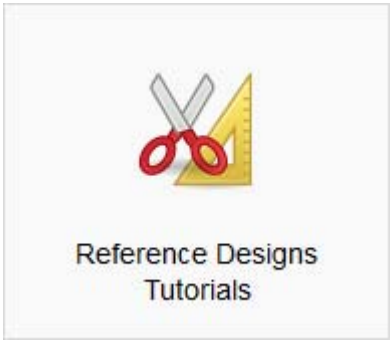
Avnet Support

- Technical support is offered online through the minized.org website support forums. MiniZed users are encouraged to participate in the forums and offer help to others when possible.



- For questions regarding the MiniZed community website, please direct questions to the ultrazed.org Web Master (webmaster@minized.org).
- To access the most current collateral for the MiniZed, visit the community support page (www.minized.org/content/support) and click one of the icons shown below:





  - MiniZed Documentation
    http://minized.org/support/documentation/???
  - MiniZed Reference Designs
    http://ultrazed.org/support/design/??

Xilinx Support

For questions regarding products within the Product Entitlement Account, send an email message to the Customer Service Representative in your region:

- Canada, USA and South America - isscs_cases@xilinx.com
- Europe, Middle East, and Africa - eucases@xilinx.com
- Asia Pacific including Japan - apaccase@xilinx.com

For technical support, including the installation and use of the product license file, contact Xilinx Online Technical Support at www.xilinx.com/support. The following assistance resources are also available on the website:

- Software, IP and documentation updates
- Access to technical support Web tools
- Searchable answer database with over 4,000 solutions
- User forums

Quick Experimentation Instructions

1. Extract the support archive to c:\Avnet
2. Open wpa_supplicant.conf, edit for SSID and PSK
3. Copy wpa_supplicant.conf to a USB flash drive
4. Plug the MiniZed into your PC using the JTAG/Serial microUSB
5. Use a terminal program (Ex. TeraTerm) to connect to the MiniZed
6. Log into the MiniZed using root/root, then execute the below commands

```
cd /usr/local/bin

ls -l

# Notice, NO bt.sh

# There is not enough space in the Factory QSPI image
```

7. Insert the USB flash drive into the Type A J1 port on the MiniZed, attach the second USB cable to the AUX Power to enable power to the USB flash drive
8. Copy over the wpa_supplicant.conf to configure the Wi-Fi by using the below commands

```
cd /run/media/mmcblk1p1

rm *

cd /run/media/sda1

ls -l

cp wpa_supplicant.conf ../mmcblk1p1/

cat ../mmcblk1p1/wpa_supplicant.conf

# Notice this is our edited file
```

9. At this point we are ready to enable the Wi-Fi

```
cd /usr/local/bin/

./wifi.sh

#Notice the WIFI LED is now running

#This configuration script overrides the OS default

#wpa_supplicant.conf with our provided file now located in the eMMC
```

10. Using the IP address that shows in the terminal window, connect to the MiniZed using a program such as WinSCP
    a. For details on this, please refer to the Getting Started Guide Located at MicroZed.org
11. Copy the boot_eMMC.bin and the image.ub file using this Wi-Fi connection showing the speed of loading the images TO the MiniZed
    a. Files should be copied to /run/media/mmcblk1p1/

12. In the terminal window, execute the following commands to actually program the QSPI with the new PetaLinux configuration, after a successful programming, execute a reboot command

```
flashcp /run/media/mmcblk1p1/boot_eMMC.bin /dev/mtd0

reboot
```

13. Log back in using root/root and execute the below commands, showing that we NOW have a Bluetooth stack in our OS

```
cd /usr/local/bin/

ls -al

#Notice we now have a bt.sh, which utilized the included Bluetooth stack
```

14. Execute the below commands, which will re-enable the Wi-Fi as well as enable the Bluetooth into a scanning mode

```
./bt.sh

#Notice the BT LED is now running

./wifi.sh

#Notice the WIFI LED is now running
```

15. To compare against traditional JTAG methods, reset to Flash-only-Boot.
16. On your PC, open an SDK 2017.1 command window and execute the below commands at the xsct% prompt – this will take some time

```
cd c:/Avnet

exec program_flash -f flash_only_boot_7007S.bin -flash_type qspi_single
```

Revision History

Date	Version	Revision
13 Jun 17	01	Initial Release