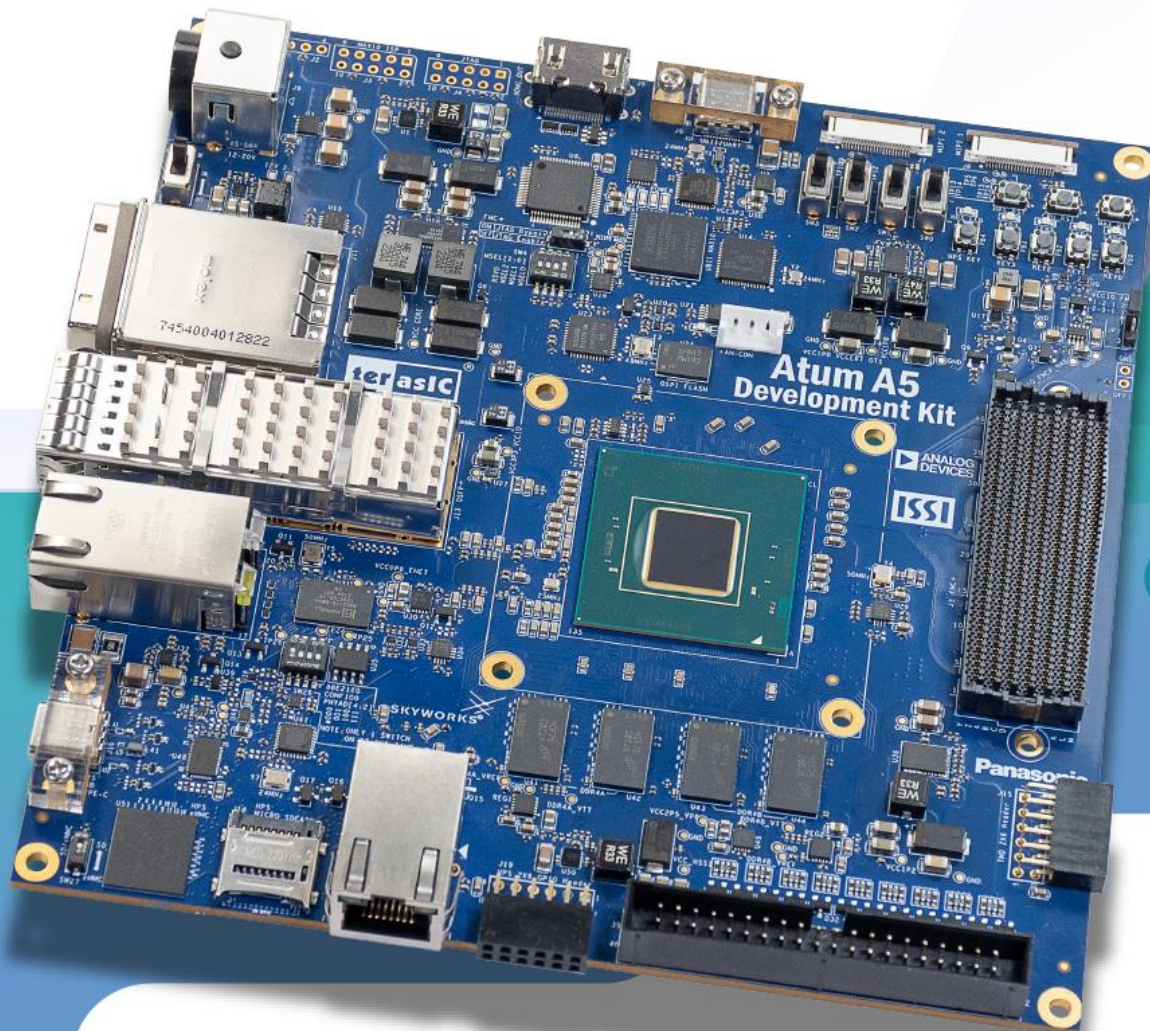


# ATUM A5 Board

## Linux Booting Started Guide

---



# CONTENTS

<b>CHAPTER 1</b>	<b><i>LINUX BOOTING ON THE ATUM A5</i></b>	<b>3</b>
1.1	INTRODUCTION .....	3
1.2	REQUIRED HARDWARE.....	3
1.3	INSTALL THE MICROSD CARD .....	3
1.4	SET THE MSEL .....	6
1.5	POWER ON THE BOARD.....	7
1.6	SETTING UP UART TERMINAL.....	8
1.7	EMMC PROGRAMMING.....	13
1.8	APPENDIX .....	23
	<b><i>ADDITIONAL INFORMATION</i></b> .....	<b>25</b>

## Chapter 1

# *Linux Booting on the ATUM A5*

## 1.1 Introduction

This guide describes how to boot the HPS on the board using the Micro SD Card with Linux image, and use the UART interface to allow the Host PC to communicate with the HPS of the board.

## 1.2 Required Hardware

To boot Linux on the board, the following hardware is required:

- ATUM A5 board
- USB Type A to Type-C Cable
- Micro SD Card (At least 4GB capacity )

## 1.3 Install the MicroSD Card

This section will show you how to how to install it into the Board. In addition, if user want to recover the factory image file to the MicroSD Card. It will show how to download the Linux image file for the Board and how to write it into the MicroSD Card.

### ■ Install the MicroSD Card to the Board

The Board will be shipped with a MicroSD card that has been written with Linux image. Users can install the Micro SD Card on the board by referring to **Figure 1-1**.

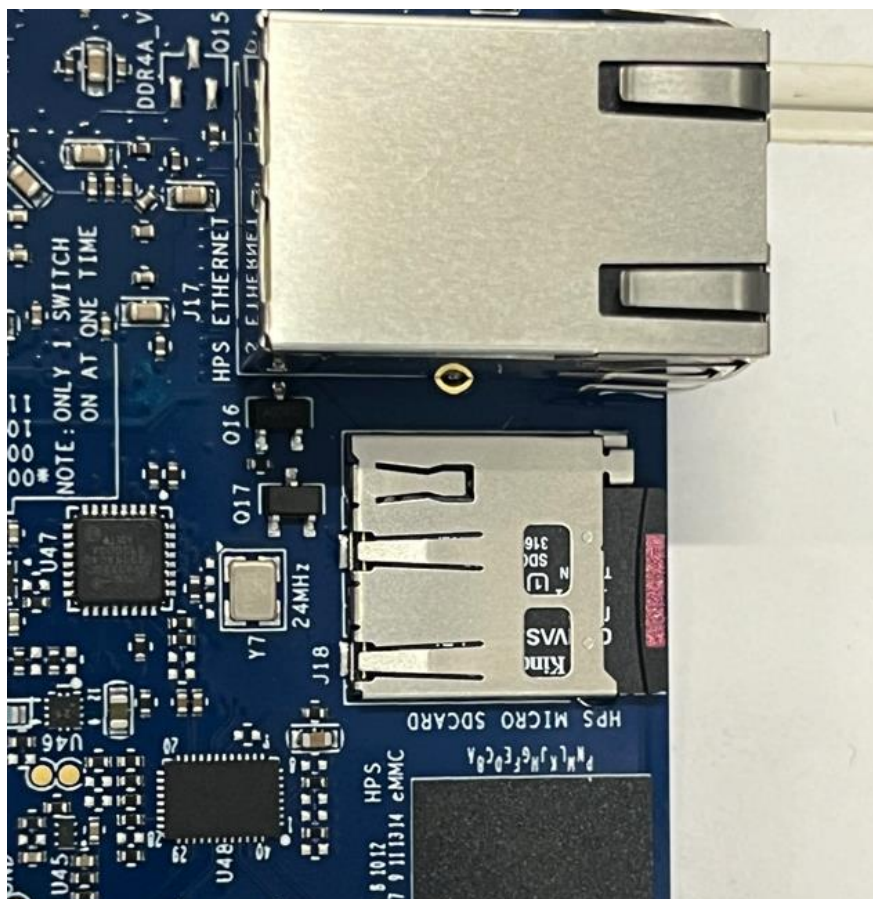


Figure 1-1 Installing MicroSD card

## ■ Download Linux image file

If the user wants to copy or re-program the MicroSD card, you can download the Linux image file (Find “*Linux BSP (Board Support Package): MicroSD Card Image*”) by referring to the link below:

<http://atum-a5.terasic.com/cd>

### Linux BSP (Board Support Package): MicroSD Card Image

標題	版本	大小	日期	下載
<a href="#">Linux BSP 1.2.0 Release Note</a>	1.2.0		2024-10-18	<a href="#">下載</a>
<a href="#">Linux Console (Ubuntu + Kernel 6.1.68-lts; rev. B Hardware)</a>	1.2.0		2024-09-24	<a href="#">下載</a>
<a href="#">Linux Console (Poky + Kernel 6.1.68-lts; rev. B Hardware)</a>	1.1.0		2024-08-07	<a href="#">下載</a>
<a href="#">Linux Console (Poky + Kernel 6.1.68-lts; rev. A Hardware)</a>	1.1.0		2024-06-18	<a href="#">下載</a>

Figure 1-2 BSP Download site

## ■ Download the programming tool

To program a MicroSD card Linux image you can use a free tool such as [Rufus](#).

## ■ Program the MicroSD Card

The SD card image file needs to be programmed to a MicroSD card before it can be used.

The steps below present how to create MicroSD card on a windows machine using Win32DiskImager.exe.

1. Connect the MicroSD card to a Windows PC
2. Execute **Rufus**
3. Select the image file for MicroSD card. For Linux Console V1.2.0 , please select “sdcard\_ubuntu.img”
4. Select the MicroSD card device
5. Click “**START**” to start writing the image file to the MicroSD card. Wait until the image is successfully written.



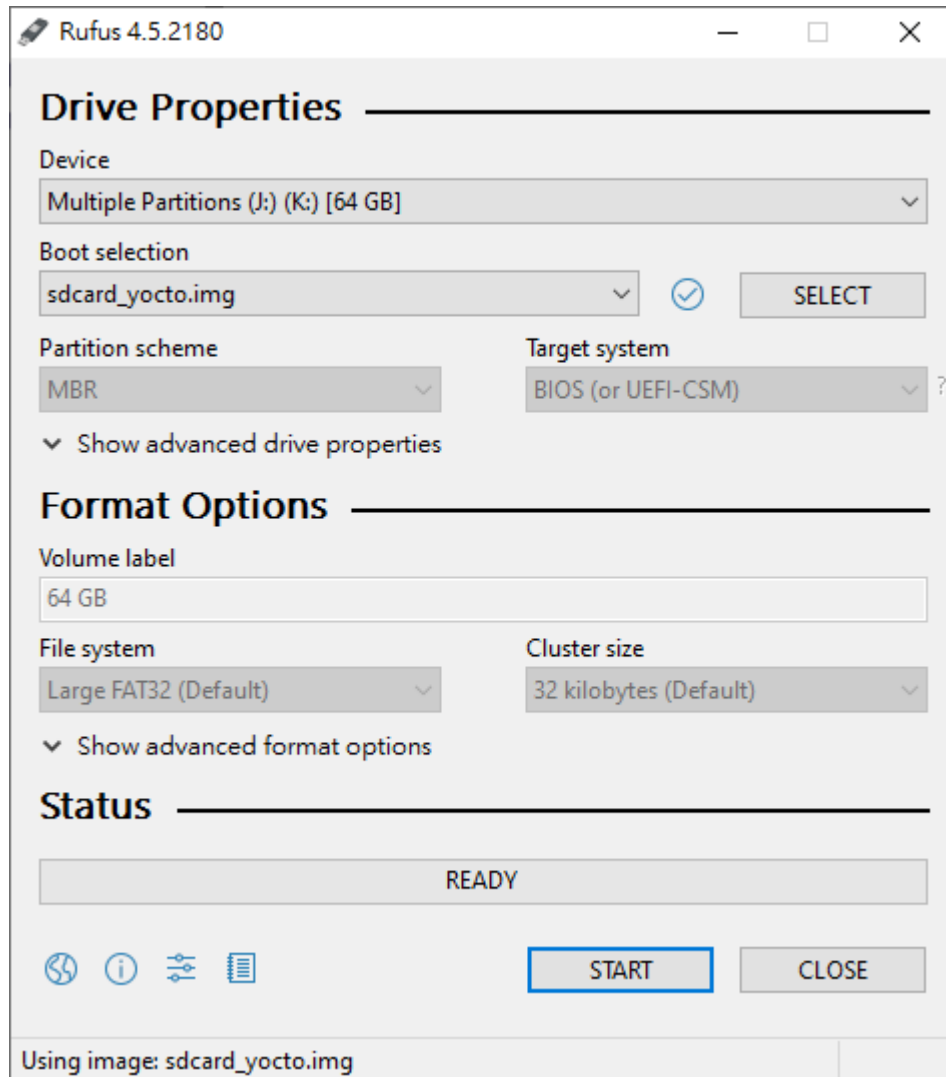
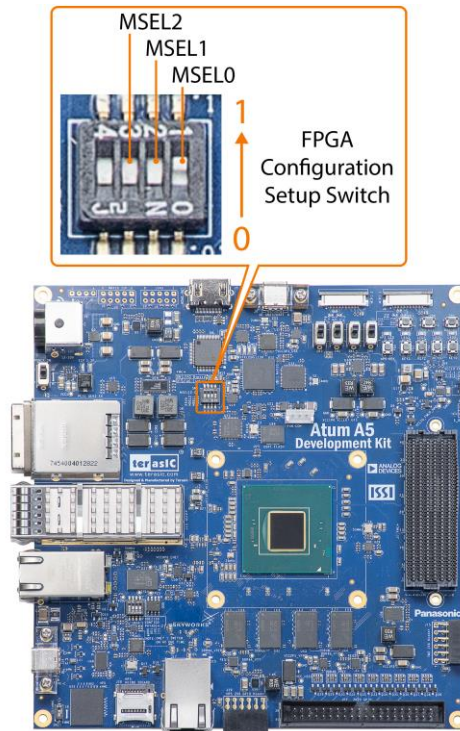


Figure 1-3 Rufus tool

## 1.4 Set the MSEL

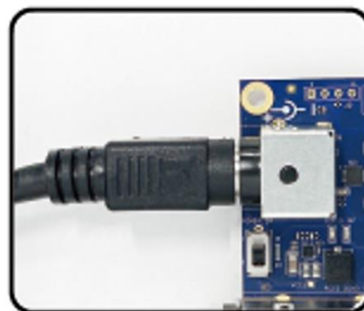
Make sure the Configure mode switch is set to AS Fast mode, please set MSEL[2:0] to "001".



**Figure 1-4 Position of slide switches SW4 for Configuration Mode**

## 1.5 Power On the Board

To power up the Board, user need to connect a 12V DC power supply to the board, then turn on the power switch SW5 on the board to power on the board (See **Figure 1-5**).



**Figure 1-5 Power on the board form external Power**

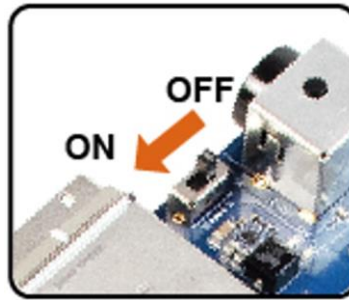


Figure 1-6 Power on the board form external Power

## 1.6 Setting Up UART Terminal

This section presents how to install the drivers for the USB to UART chip on the Board and how to set up the UART terminal on your Host PC. The Board communicates with the PC through the Micro USB connector. You should install the USB to UART driver and configure the UART terminal before you run Linux on the board (see [The CP2105 \(USB to UART\) Driver Installation Instructions](#)).

### ■ Installing the Driver

1. Connect your computer to the development board by plugging the USB cable into the USB Type-C connector of the board. (Connection setup is shown in **Figure 1-5** )

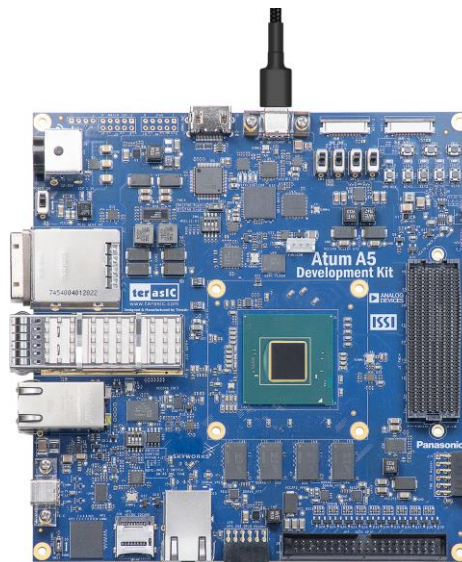


Figure 1-7 Connect the Micro USB cable to the board



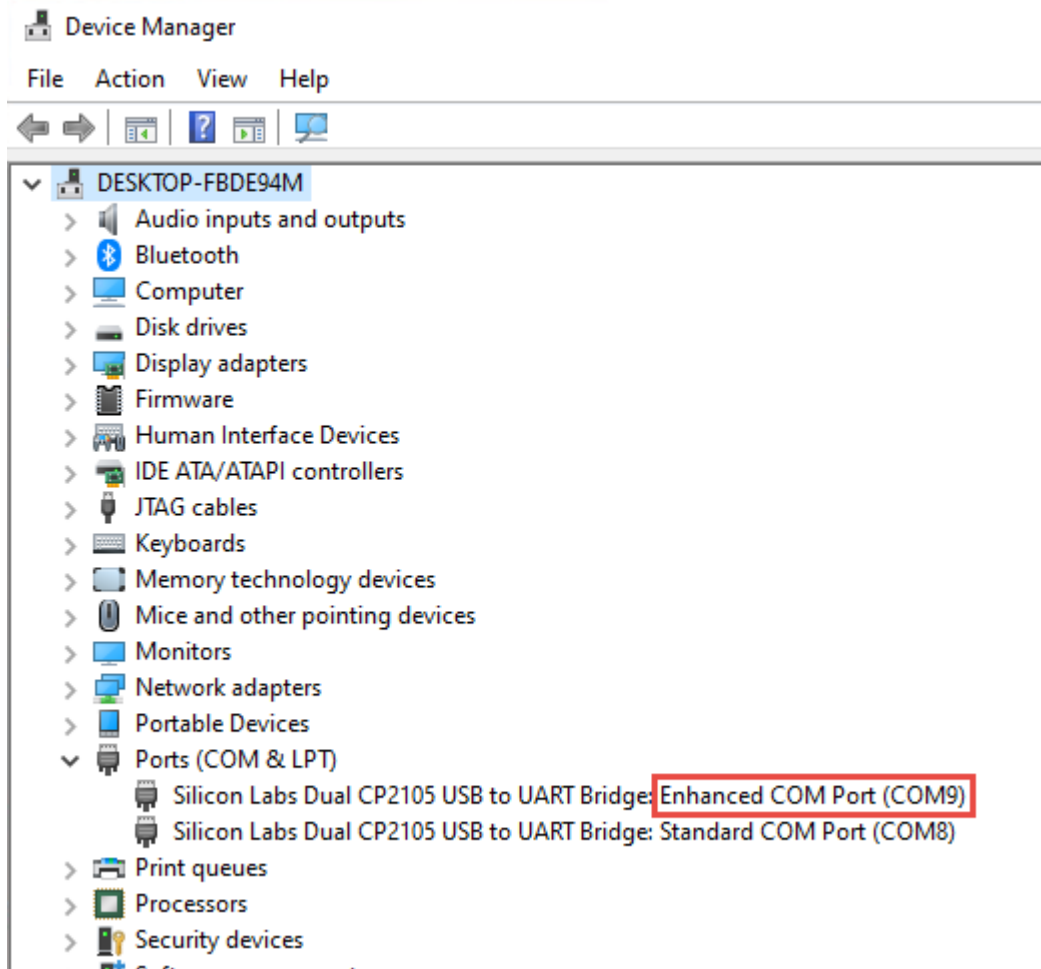
2. Please refer to the [The CP2105 \(USB to UART\) Driver Installation Instructions](#) to install the USB to UART driver for HPS fabric.

## ■ Configure UART terminal UART terminal spec

- 115200 baud rate
- no parity
- 1 stop bit
- no flow control settings

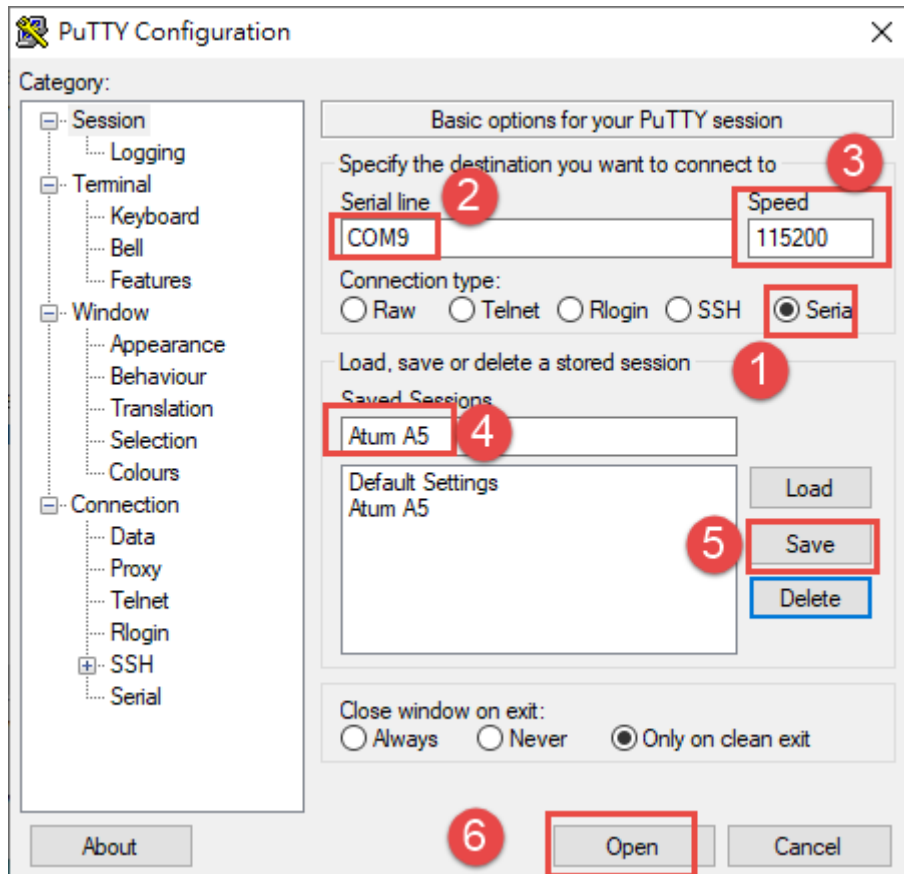
The following steps show how to configure a PuTTY terminal window (can be downloaded from the link: <http://the.earth.li/~sgtatham/putty/latest/x86/putty.exe>)

1. Open the “Device Manager” on your windows and check the “Port(COM&LPT)” tab. User may find the Silcon UART device CP2105 on the list. Find the COM number of “**Enhanced COM port**”. It represents the HPS UART Port. See **Figure 1-8**, the COM number of this Host is COM9. *Note that the “**COM9**” on the Serial Line column needs to be modified according to the actual com port on the user's computer.*



**Figure 1-8 Device Manager**

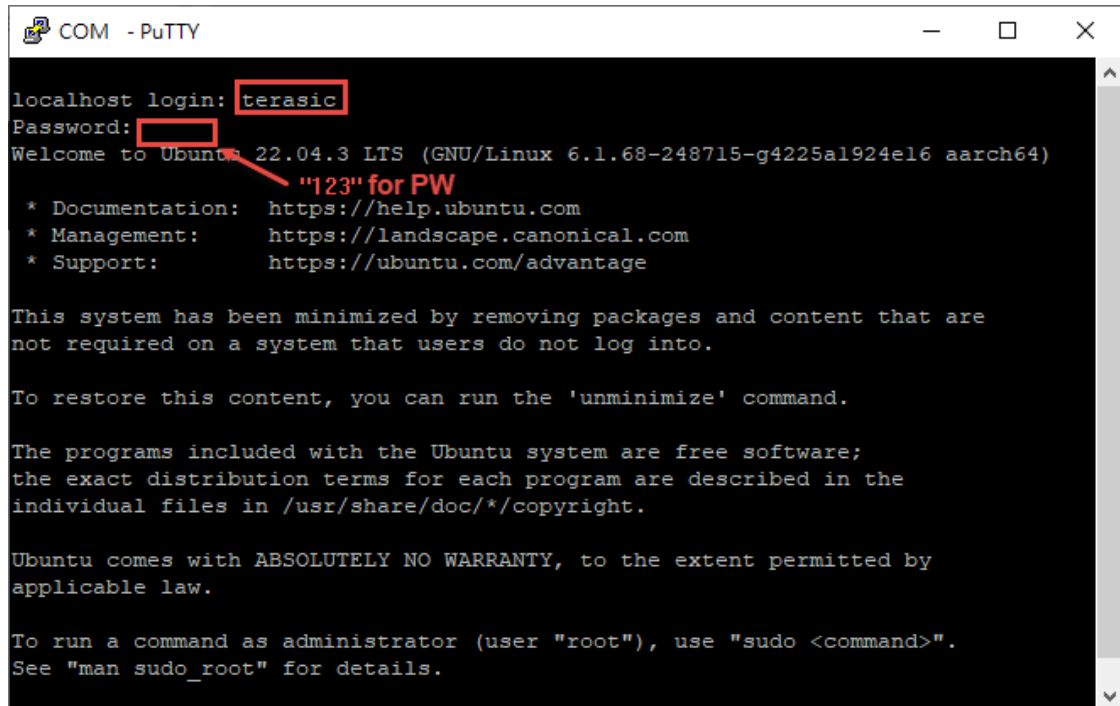
2. Open putty.exe, click Serial go to a serial configure interface.
3. Configure the window like the flowing picture and click “save” button to save the setting and click “Open” to open the terminal window. *Note that the “COM9” on the Serial Line column needs to be modified according to the actual com port on the user's computer.*



**Figure 1-9 Putty Window**

4. After the board is successfully booted, the Linux will ask for the login name.
- If user use the image “Linux BSP 1.2.0 (Ubuntu + Kernel 6.1.68-lts; rev. B Hardware)”, please type “**terasic**” for account name and “123” for the password to login Ubuntu(See **Figure 1-10**).

**Note :** If the UART terminal does not respond, please refer to Appendix 1.8 to troubleshoot the issue.



```
COM - PuTTY

localhost login: terasic
Password: 123
Welcome to Ubuntu 22.04.3 LTS (GNU/Linux 6.1.68-248715-g4225a1924e16 aarch64)

 * Documentation:  https://help.ubuntu.com
 * Management:    https://landscape.canonical.com
 * Support:       https://ubuntu.com/advantage

This system has been minimized by removing packages and content that are
not required on a system that users do not log into.

To restore this content, you can run the 'unminimize' command.

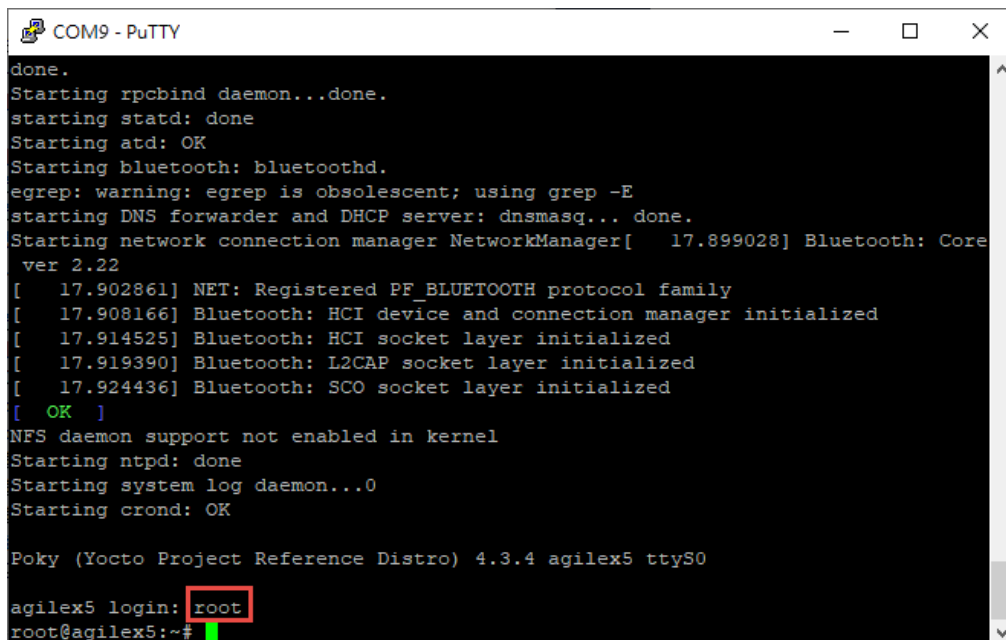
The programs included with the Ubuntu system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Ubuntu comes with ABSOLUTELY NO WARRANTY, to the extent permitted by
applicable law.

To run a command as administrator (user "root"), use "sudo <command>".
See "man sudo_root" for details.
```

Figure 1-10 Putty Window

- For the image “Linux BSP 1.1.0 (Poky + Kernel 6.1.68-lts; rev. B Hardware)”, type “root” for account name and NO Need for the password (See Figure 1-11)



```
COM9 - PuTTY

done.
Starting rpcbind daemon...done.
starting statd: done
Starting atd: OK
Starting bluetooth: bluetoothd.
egrep: warning: egrep is obsolescent; using grep -E
starting DNS forwarder and DHCP server: dnsmasq... done.
Starting network connection manager NetworkManager[ 17.899028] Bluetooth: Core
ver 2.22
[ 17.902861] NET: Registered PF_BLUETOOTH protocol family
[ 17.908166] Bluetooth: HCI device and connection manager initialized
[ 17.914525] Bluetooth: HCI socket layer initialized
[ 17.919390] Bluetooth: L2CAP socket layer initialized
[ 17.924436] Bluetooth: SCO socket layer initialized
[ OK ]
NFS daemon support not enabled in kernel
Starting ntpd: done
Starting system log daemon...0
Starting crond: OK

Poky (Yocto Project Reference Distro) 4.3.4 agilex5 ttyS0

agilex5 login: root
root@agilex5:~#
```

Figure 1-11 Putty Window

## 1.7 eMMC Programming

This section will guide you on how to program the user's owned image file to the eMMC (embedded MultiMedia Card) of the ATUM A5 board and configure the HPS to boot from the eMMC.

A detailed process introduction is as follows:

1. **Image Splitting:** Due to DDR4 space limitations of the board, users need to split their image files into two parts. The split files will be stored on the micro SD card and copied to the DDR4 memory in the U-Boot environment for subsequent programming to the eMMC.
2. **Overwriting the SD Card Image:** Overlay the split image files onto the FAT partition of the SD card image provided by Terasic.
3. **System Startup and Entering U-Boot:** Insert the SD card into the ATUM A5 board and power it on to enter the U-Boot environment.
4. **Image File Programming:** In U-Boot, program the two split image files to the eMMC sequentially.
5. **System Startup Verification:** After the burning is complete, verify whether the system can boot the HPS (Hardware Processing System) from the eMMC.

A detailed process introduction is as follows:

### ■ Step 1: Image Splitting

As mentioned previously, due to the limited capacity of the board's DDR4 memory, users need to split their image files into two parts. Here we will use the SD card image provided by Terasic (*sdcard\_ubuntu.img*) as an example to demonstrate the process in detail. Users can split the image files into two parts using the following command in a Linux or WSL environment:

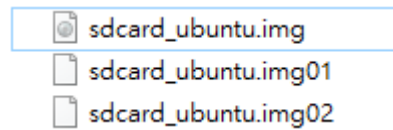
```
split -b 1950M --numeric-suffixes=1 sdcard_ubuntu.img sdcard_ubuntu.img
```

```
johnny@johnny:/mnt/g$ split -b 1950M --numeric-suffixes=1 sdcard_ubuntu.img sdcard_ubuntu.img
johnny@johnny:/mnt/g$
```



**Figure 1-12 Splitting image file**

Upon completion of the command, two separate image files were generated.



**Figure 1-13 Split Image files**

## ■ Step 2: Overwriting the SD Card Image

1. Prepare the SD Card Image:

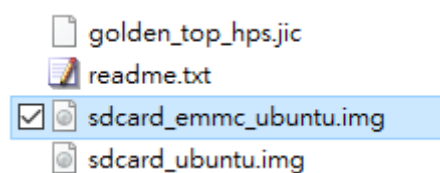
Download the Image: Go to the [Terasic Atum A5 resource page](#) and download the Linux Console file (version 1.2.0 or later).

Linux BSP (Board Support Package): MicroSD Card Image

Title	Version	Size	Date	Download
<a href="#">Linux Console (Kernel 6.1.68-lts; rev. B Hardware)</a>	1.2.0		2024-09-24	 
<a href="#">Linux Console (Kernel 6.1.68-lts; rev. B Hardware)</a>	1.1.0		2024-08-07	 
<a href="#">Linux Console (Kernel 6.1.68-lts; rev. A Hardware)</a>	1.1.0		2024-06-18	 

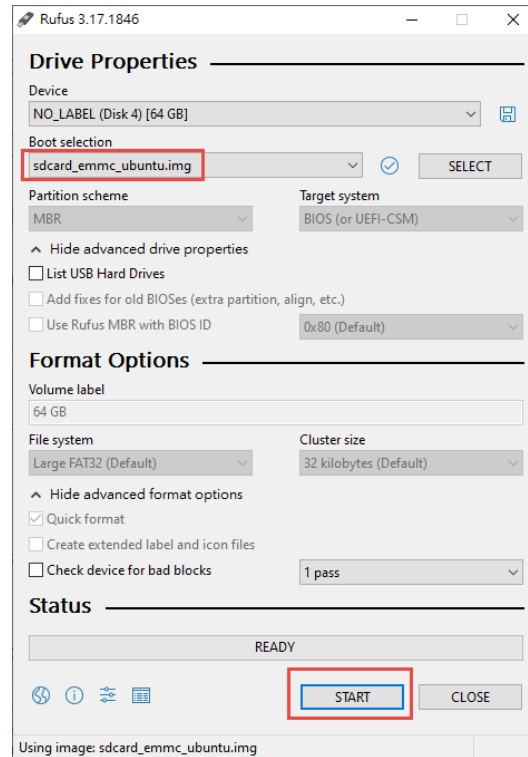
**Figure 1-14 Split Image files**

Extract the downloaded archive and locate the *sdcard\_emmc\_ubuntu.img* file.



**Figure 1-15 Split Image files**

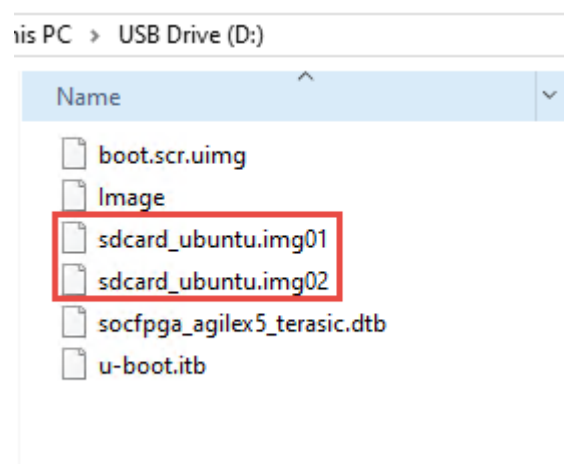
Use a tool like Rufus to program the *sdcard\_emmc\_ubuntu.img* file to an SD card.



**Figure 1-16 Split Image files**

## 2. Overwrite the Split Image Files :

Insert the SD card into your computer and open the FAT partition in Windows or Linux. You will find two split image files in the FAT partition of the SD card. Overwrite these two split files with the two image files you generated in the step 1.

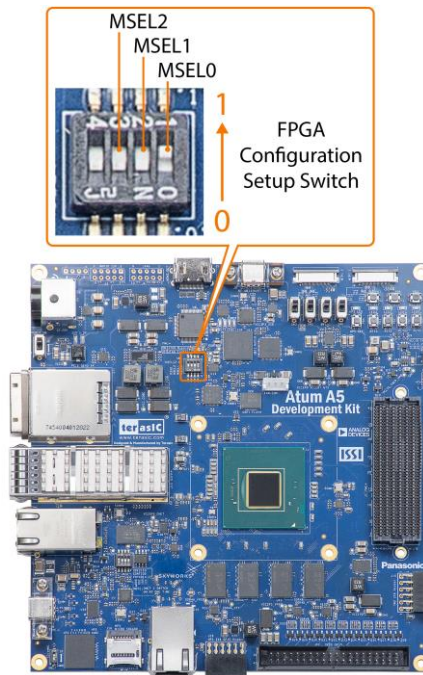


**Figure 1-17 Split Image files**

### ■ Step 3: System Startup and Entering U-Boot:

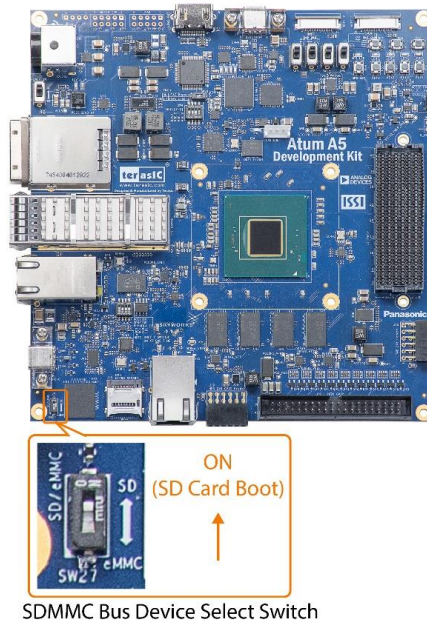
1. Insert the SD card prepared in Step 2 into the Atum A5 board and verify the following switch settings:

- i. **MSEL Setting Switch (SW4):** Set to AS mode (MSEL[2:0] = 001), as shown in the figure.



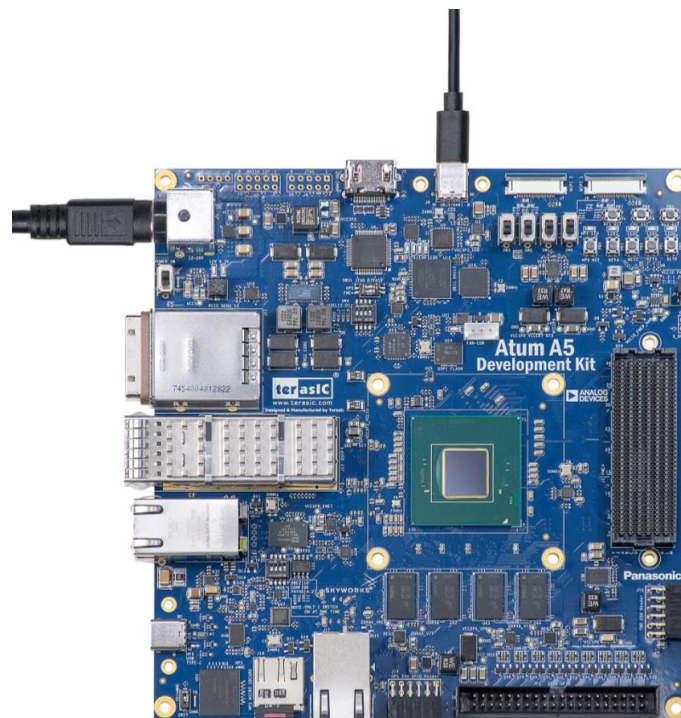
**Figure 1-18 MSEL Setting Switch setting**

- ii. **SDMMC Bus Device Select Switch (SW27):** Set to the ON position. This setting indicates that the Hard Processor System (HPS) will boot from the SD card device.



**Figure 1-19 SDMMC Bus Device Select Switch**

2. Connect the Atum A5 board to the host PC using the power cable and Type-C USB cable as shown in the figure.

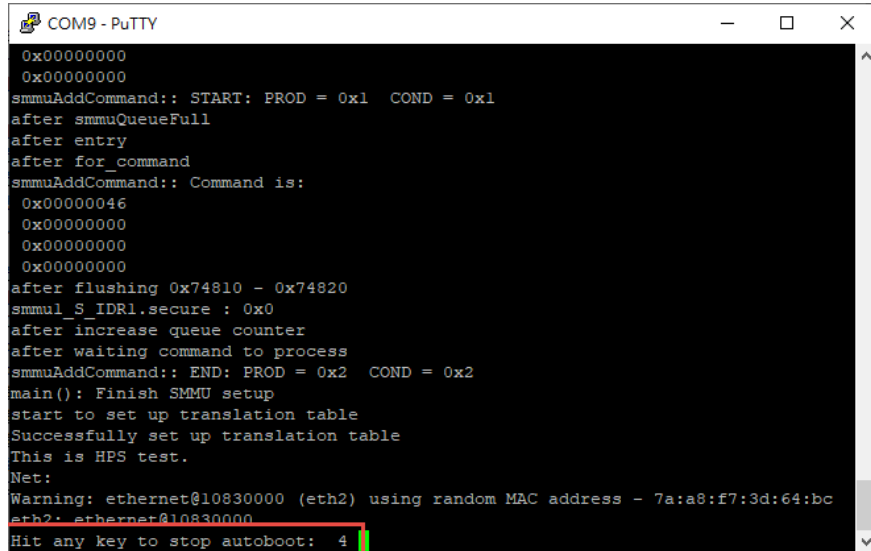


**Figure 1-20 Power and USB cable setting**

3. Open a UART terminal tool (e.g., PuTTY) on the host PC to communicate with the HPS on the

Atum A5 board. User can refer to section 1.6 for detailed.

4. Power on the Atum A5 board and observe the terminal window. When the prompt "**Hit any key to stop autoboot**" appears, press any key to enter U-Boot.



```

COM9 - PuTTY
0x00000000
0x00000000
smmuAddCommand:: START: PROD = 0x1 COND = 0x1
after smmuQueueFull
after entry
after for_command
smmuAddCommand:: Command is:
0x00000046
0x00000000
0x00000000
0x00000000
after flushing 0x74810 - 0x74820
smmul_S_IDR1.secure : 0x0
after increase queue counter
after waiting command to process
smmuAddCommand:: END: PROD = 0x2 COND = 0x2
main(): Finish SMMU setup
start to set up translation table
Successfully set up translation table
This is HPS test.
Net:
Warning: ethernet@10830000 (eth2) using random MAC address - 7a:a8:f7:3d:64:bc
eth2: etheraddr@10830000
Hit any key to stop autoboot: 4

```

Figure 1-21 Enter the U-Boot

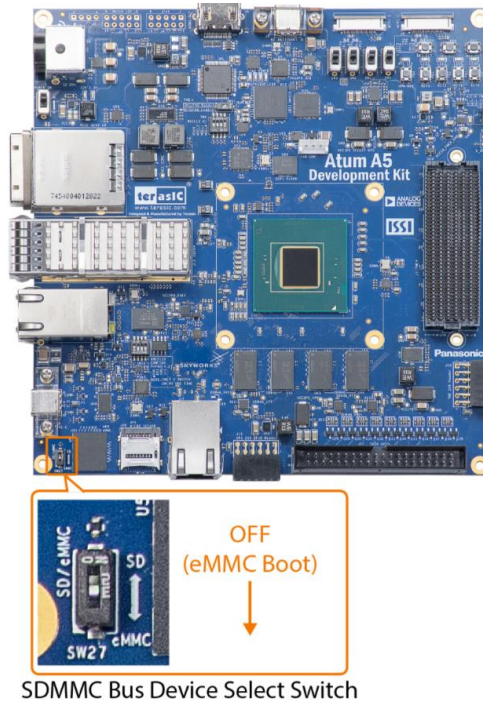
## ■ Step 4: Image File Programming:

1. In U-Boot, In U-Boot the following commands to load the sdcard\_ubuntu.img01 file from the SD card to the DDR4 memory:

```
fatload mmc 0:1 $loadaddr sdcard_ubuntu.img01
setexpr blkcnt1 ${filesize} / 0x200
```

2. Switch the SDMMC bus device select switch (SW27) to the OFF position to allow the HPS to access the eMMC.





**Figure 1-22 Setting eMMC boot**

3. Execute the following commands to verify that the HPS is currently accessing the eMMC and its capacity is **7.3 GiB**.

```
mmc rescan  
mmc info
```

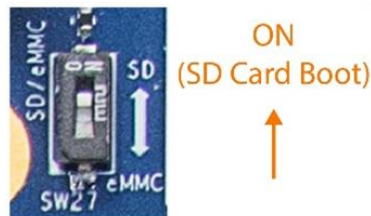
```
COM9 - PuTTY
2044723200 bytes read in 87727 ms (22.2 MiB/s)
SOCFPGA_AGILEX5 # setexpr blkcnt1 ${filesize} / 0x200
SOCFPGA_AGILEX5 # mmc rescan
SOCFPGA_AGILEX5 # mmc info
Device: mmc0@10808000
Manufacturer ID: 45
OEM: 0
Name: DG4008
Bus Speed: 52000000
Rd Block Len: 512
MMC version 5.1
High Capacity: Yes
Capacity: 7.3 GiB
Bus Width: 4-bit
Erase Group Size: 512 KiB
HC WP Group Size: 8 MiB
User Capacity: 7.3 GiB WRREL
Boot Capacity: 4 MiB ENH
RPMB Capacity: 4 MiB ENH
Boot area 0 is not write protected
Boot area 1 is not write protected
SOCFPGA_AGILEX5 # mmc write $loadaddr 0 $blkcnt1
MMC write: dev # 0, block # 0, count 3993600 ...
```

**Figure 1-23 Check eMMC size**

- Execute the following commands to write the data in the DDR4 memory to the beginning of the eMMC.

```
mmc write $loadaddr 0 $blkcnt1
```

- Switch the SDMMC bus device select switch (SW27) back to the ON position to allow the HPS to access the SD card.



**Figure 1-24 Setting SD Card boot**

- Execute the following commands in sequence and confirm the capacity. At this time, the capacity of the SD card should be displayed, not eMMC.

```
mmc rescan
mmc info
```

```

COM9 - PuTTY
Erase Group Size: 512 KiB
HC WP Group Size: 8 MiB
User Capacity: 7.3 GiB WRREL
Boot Capacity: 4 MiB ENH
RPMB Capacity: 4 MiB ENH
Boot area 0 is not write protected
Boot area 1 is not write protected
SOCFPGA_AGILEX5 # mmc write $loadaddr 0 $blkcnt1
MMC write: dev # 0, block # 0, count 3993600 ... 3993600 blocks written: OK
SOCFPGA_AGILEX5 # mmc rescan
SOCFPGA_AGILEX5 # mmc info
Device: mmc0@10808000
Manufacturer ID: 27
OEM: 5048
Name: SD64G
Bus Speed: 50000000
Rd Block Len: 512
SD version 3.0
High Capacity: Yes
Capacity: 58 GiB
Bus Width: 4-bit
Erase Group Size: 512 Bytes
SOCFPGA_AGILEX5 #

```

Figure 1-25 Check SD Card size

- Execute the following commands to load the sdcard\_ubuntu.img02 file from the SD card to the DDR4 memory:

```
fatload mmc 0:1 $loadaddr sdcard_ubuntu.img02
setexpr blkcnt2 ${filesize} / 0x200
```

- Set the SDMMC Bus Device Select Switch (SW27) on the board to the OFF position again so that the HPS can access eMMC.
- Execute the following commands in sequence to confirm that the capacity is correct (7.3 Gib), which means that the current HPS access device is eMMC.

```
mmc rescan
mmc info
```

- Confirm that the capacity is correct, and then execute the following command to write DDR4 data to eMMC.

```
mmc write ${loadaddr} ${blkcnt1} ${blkcnt2}
```

11. Keep the SDMMC bus device select switch (SW27) in the OFF position to ensure the system boots from the eMMC.

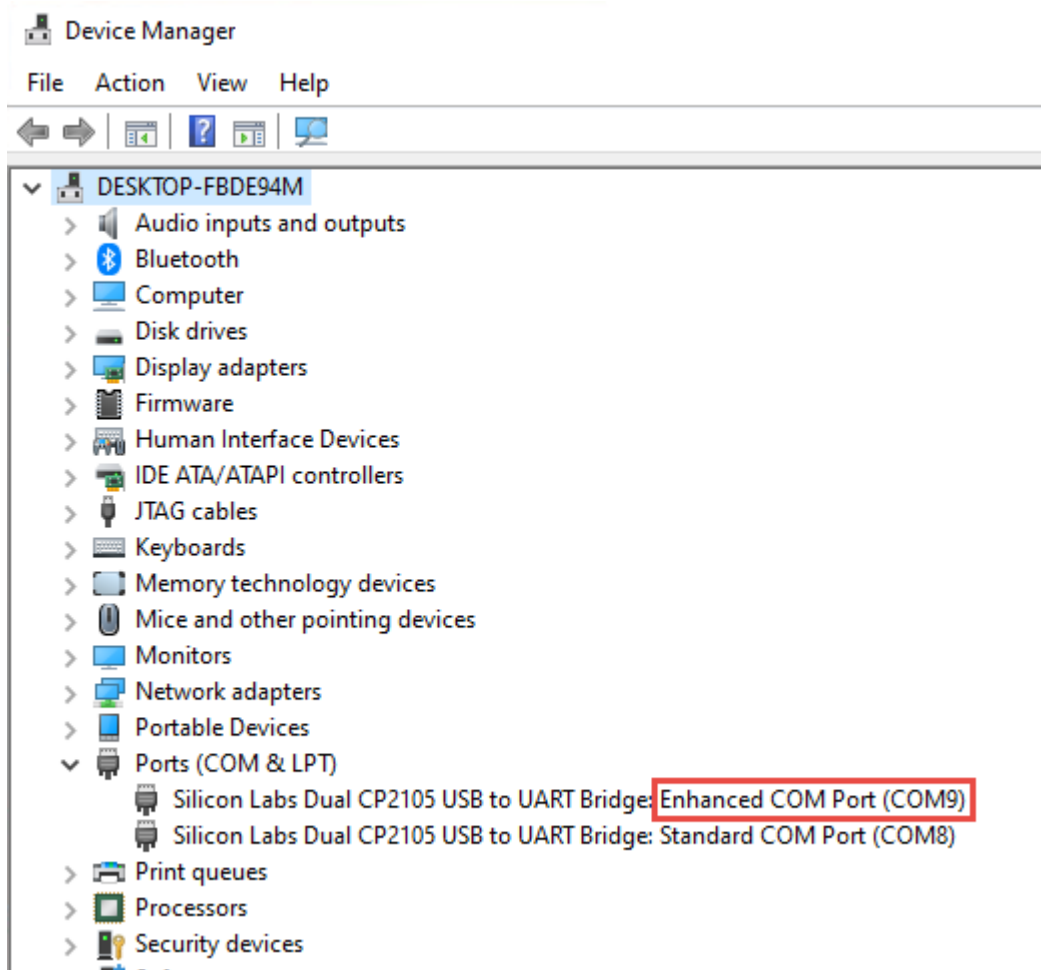
## ■ Step 5: System Startup Verification:

Power cycle the board and observe the system boot process in the terminal tool. If the system boots successfully from the eMMC, you will enter the Linux system login screen.

## 1.8 Appendix

This section will introduce what check items can be done if Linux cannot be boot and the putty window does not print any messages.

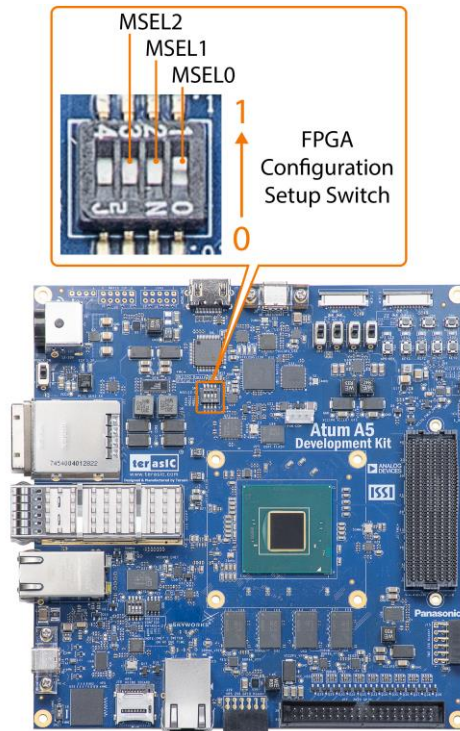
1. Check if the USB Serial Port shows on the device manager on the computer.



**Figure 1-26 Hardware Setup for UART Terminal**

2. Make sure the Configure mode switch is set to AS mode.





**Figure 1-27 Position of slide switches SW4 for Configuration Mode**

3. The QSPI flash on the Board had programmed the boot file when shipped. After power on, user can check if the user LED is flashing, and after 10 seconds of booting, the HPS LED has light on. If not, please refer to following steps to re-program the QSPI flash with the factory code.
  - Connect the USB cable to USB blaster II connector of the Board.
  - Copy the factory code from the path :  
System CD\ Demonstration\SoC\_FPGA\GHRD\output\_files\program\_qspi\_flash\
  - Execute “flash\_program.bat” to erase and program the QSPI flash.

# Additional Information

## Contact Terasic

Here are the addresses where you can get help if you encounter problems:

### ■ Terasic Technologies

No.80, Fenggong Rd., Hukou Township, Hsinchu County 303035. Taiwan

Email: [support@terasic.com](mailto:support@terasic.com)

Web: [www.terasic.com](http://www.terasic.com)

Agilex 7 FPGA Starter Kit Web: ATUM A5.terasic.com

### ■ Revision History

Date	Version	Changes
2024.07	First publication	
2024.09	V1.1	Add eMMC programming guide
2025.01	V1.2	Update V1.2 BSP