



# ASPEED

## Graphics User Guide

ASPEED



## Table of Contents

Revision History.....	3
Chapter 1..... Overview	4
Chapter 2..... Video BIOS	6
Chapter 3..... UEFI Graphic Output protocol	7
3.1    VBIOS / UEFI Package List	7
3.2    Support List	8
3.3    Installation	8
3.4    Q & A	9
Chapter 4..... Windows Driver	10
4.1    Package List	10
4.2    Support List	10
4.3    Installation	10
4.4    Q & A	10
Chapter 5..... Linux Driver	12
5.1    Package List	12
5.2    Support List	13
5.3    Installation	13
5.4    Q&A	15



## Revision History

The following table lists the revision history of the ASPEED Graphics User Guide from release to release.

Date	Version	Description
December 2022	1.0	Initial version
December 2022	1.1	Address pantsdown issue, <a href="#">CVE-2019-6260</a> , in QA of VBIOS

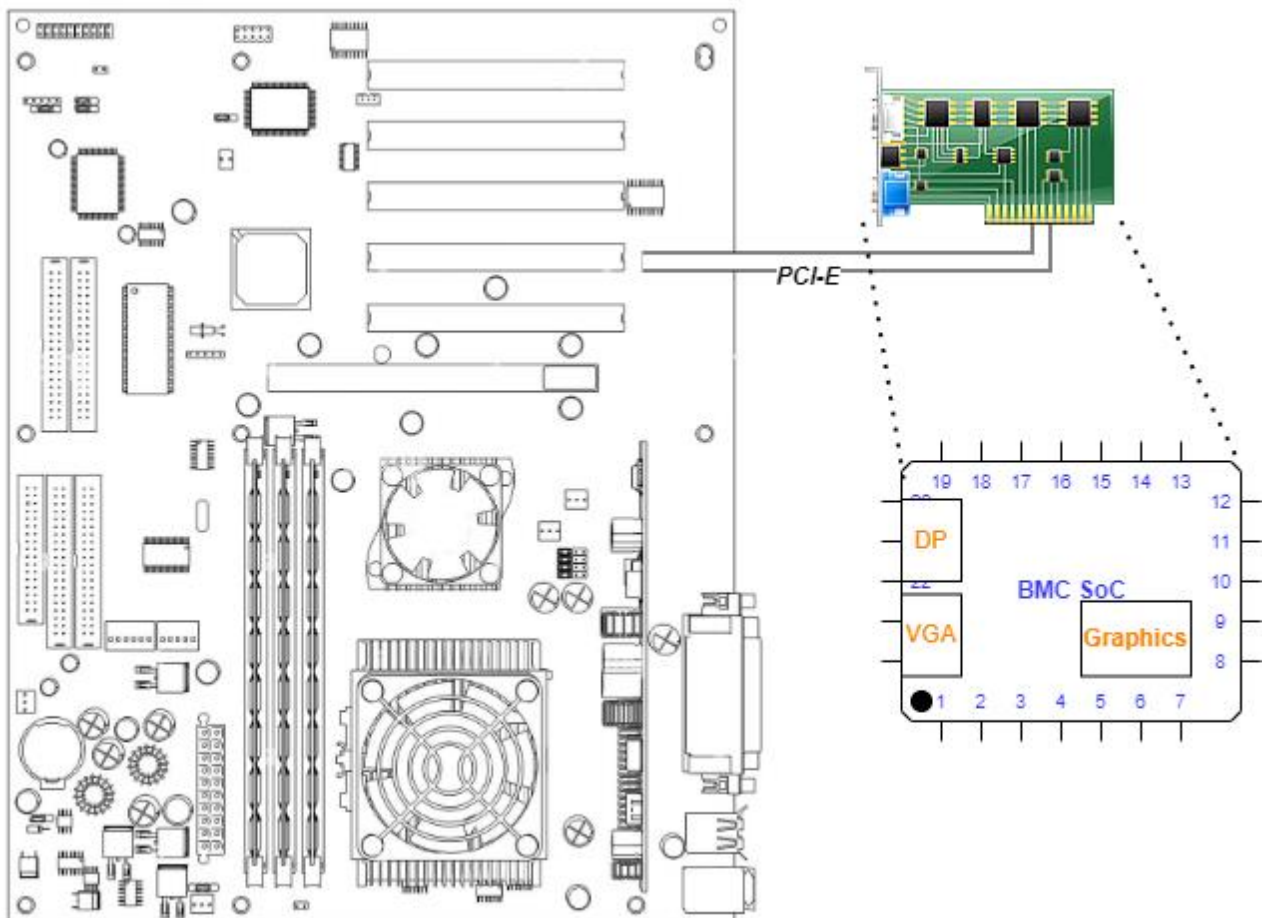
ASPEED

## Chapter 1. Overview

This document provides the information of ASPEED Graphics driver for the ASPEED Graphics controller, the one of the key modules integrated by ASPEED BMC SoC. Three kinds of driver are supported:

- video BIOS(**VBIOS**) which is the BIOS of a graphics card, graphic output protocol (**GOP**) which is enabled by UEFI to support graphic console output
- Windows display driver model (**WDDM**) driver which is the new generation of display module from Microsoft
- Linux Direct Rendering Manager (**DRM**) driver which is a subsystem of the Linux kernel responsible for interfacing with graphic card.

For the system, BMC plays the role as a graphics card which generate output image to the display device through VGA or DisplayPort as below. The graphics feature is totally controlled by the host system, and that's why you will need driver mentioned above to make it work.





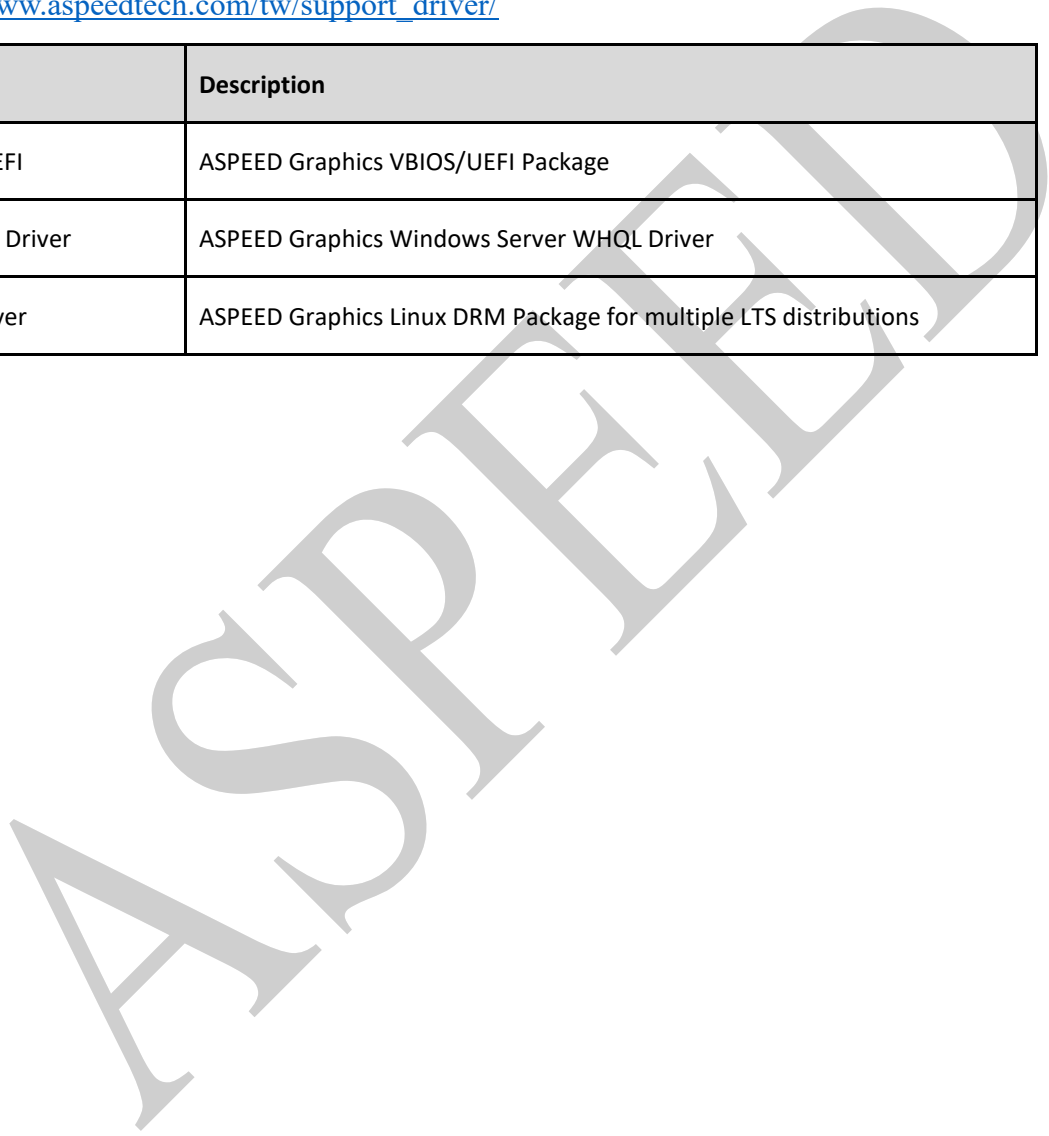
DisplayPort on BMC is not directly controlled by Graphics. Instead, it is controlled by MCU per Graphics' information. If there is any problem on DisplayPort, please refer to *SDK\_User\_Guide Chapter 27*.

❖ **Download package**

From ASPEED website:

[https://www.aspeedtech.com/tw/support\\_driver/](https://www.aspeedtech.com/tw/support_driver/)

Driver	Description
VBIOS/UEFI	ASPEED Graphics VBIOS/UEFI Package
Windows Driver	ASPEED Graphics Windows Server WHQL Driver
Linux Driver	ASPEED Graphics Linux DRM Package for multiple LTS distributions



## Chapter 2. Video BIOS

Video BIOS (VBIOS) is the BIOS of a graphics card in a computer has compatibility with IBM registers. It initializes the graphics card at the computer's boot time. It also implements INT 10h interrupt and VESA BIOS Extensions (VBE) for basic text and video mode output before a specific video driver is loaded.

More detail information, please refers the manual of VGA from IBM:

[http://bitsavers.trailing-edge.com/pdf/ibm/pc/cards/IBM\\_VGA\\_XGA\\_Technical\\_Reference\\_Manual\\_May92.pdf](http://bitsavers.trailing-edge.com/pdf/ibm/pc/cards/IBM_VGA_XGA_Technical_Reference_Manual_May92.pdf)

ASPEED VBIOS ROM for the ASPEED Graphics display controller implements INT 10h interrupt and [https://en.wikipedia.org/wiki/VESA\\_BIOS\\_Extensions](https://en.wikipedia.org/wiki/VESA_BIOS_Extensions) VBE functions.

### ❖ BIOS memory layout:

Video BIOS is located at C0000-C7FFF.

Linear Address Range	Real-Mode Address Range	Memory Type	use
0-3FF	0000:0000-0000:03FF	RAM	real-mode interrupt vector table
400-4FF	0040:0000-0040:00FF		BIOS data area
500-9FBFF	0050:0000-9000:FBFF		free conventional memory
9FC00-9FFF	9000:FC00-9000:FFFF		extended BIOS data area
A0000-BFFFF	A000:0000-B000:FFFF	video RAM	VGA framebuffers
C0000-C7FFF	C000:0000-C000:7FFF	ROM	video BIOS (32K is typical size)
C8000-EFFFF	C800:0000-E000:FFFF	NOTHING	
F0000-FFFFF	F000:0000-F000:FFFF	ROM	motherboard BIOS (64K is typical size)
100000- FEBFFFFF		RAM	free extended memory (1 meg and above)
FEC00000- FFFFFFFF		various	motherboard BIOS, PnP NVRAM, ACPI, etc.

## Chapter 3. UEFI Graphic Output protocol

The goal of Graphics Output Protocol (GOP) Driver is to replace the functionality that currently exists with Graphics hardware and its corresponding video BIOS. The Graphics Output Protocol is a software abstraction and its goal is to support any foreseeable graphics hardware and not require Graphics hardware, while at the same time also lending itself to implementation on the current generation of Graphics hardware.

More detail information, please refers UEFI spec:

[https://uefi.org/sites/default/files/resources/UEFI\\_Spec\\_2\\_9\\_2021\\_03\\_18.pdf](https://uefi.org/sites/default/files/resources/UEFI_Spec_2_9_2021_03_18.pdf)

### 3.1 VBIOS / UEFI Package List

```
UEFI
├── Release.txt
├── ReadMe.txt
├── AARCH64
├── X64
├── UEFI_ROM
│   ├── Release.txt
│   ├── ReadMe.txt
│   ├── AARCH64
│   └── X64
├── VBIOS
│   ├── ReadMe.txt
│   ├── Release.txt
│   ├── ast2500
│   ├── ast2500.r4
│   ├── ast2600
│   ├── ast2600.r4
│   └── ast2600.vga
└── VBIOS+UEFI_ROM
    ├── Release.txt
    ├── ReadMe.txt
    └── X64
```

- UEFI: UEFI (.EFI) binary folder
  - Release.txt .EFI file Release history.
  - Readme.txt Readme file to explain every binary.
  - \AARCH64 ARM64 version (.EFI) format GOP driver.
  - \X64 X64 version (.EFI) format GOP driver.
- UEFI\_ROM: UEFI (.ROM, extension ROM format) binary folder

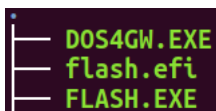
- Release.txt .ROM file Release history.
- Readme.txt Readme file to explain every binary.
- \AARCH64 ARM64 version (.ROM) format GOP driver.
- \X64 X64 version (.ROM) format GOP driver.
- VBIOS: Legacy VBIOS ROM binary folder
  - Release.txt VBIOS Release ROM history.
  - Readme.txt Readme file to explain every binary.
  - \ast2500 VBIOS ROM binary for ast2500.
  - \ast2500.r4 VBIOS ROM binary for ast2500 with reserved 4MB frame buffer.
  - \ast2600 VBIOS ROM binary for ast2600.
  - \ast2600.r4 VBIOS ROM binary for ast2600 with reserved 4MB frame buffer.
  - \ast2600.vga VBIOS ROM binary for ast2600 without display port support.
- VBIOS+UEFI: Legacy VBIOS and UEFI ROM merged binary folder (EVB supported)
  - Release.txt Merged binary Release history.
  - Readme.txt Readme file to explain every binary.
  - \X64 X64 version merged format binary.

## 3.2 Support List

Until now, ast2500 and ast2600 under X64 and ARM64 (start to be supported from v1.13.02) pre-OS will be supported in these binaries. For more detailed information, please refer readme and release files under every release folder.

## 3.3 Installation

The .efi format gop driver (under \UEFI) should be merged into UEFI system BIOS by customer. The .rom file could be flashed into external flash by flash tools that are located every ROM folder. Below are some descriptions about these tools:



- FLASH.EXE & DOS4GW.EXE: Legacy flashed tool under DOS
- flash.efi: UEFI version flashed tool

**(CAUTION: PLEASE MAKE SURE YOUR SYSTEM BEFORE FLASH ANY BINARY INTO YOUR FLASH)**



### 3.4 Q & A

**Q 1:** How to check the VBIOS version information?

Using the tool that is could read flat memory under Dos. For example [debug.exe](#), [ru.exe](#) and try to dump the memory **0xC000:0**(Segment:offset) or **0xC0000**(Flat address). The version office is under 0x10 ~ 0x16. In this case, the version will be **v1.13.02**.

```

10 00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F Refresh : ON
00 55 AA 40 EB 73 F9 D8 05 00 00 00 00 00 00 00 U.@.s.....
10 31 2E 31 33 2E 30 32 00 44 00 86 68 5C 00 49 42 1.13.02 D..h\..IB
  
```

**Q 2:** How to check the UEFI version information?

Using the “**drivers**” command under UEFI shell. In this command, every driver will be shown on the shell. Below is a partial driver information that is came from a system that the ast2600 is installed on it. In this case, the driver version is v1.13.02

```

          T   D
D         Y C I
R         P F A
V VERSION  E G G #D #C DRIVER NAME          IMAGE NAME
=====
16F 00011302 B - - 1 1 ASPEED Graphics Driver  Offset(0x8100,0xF5FF)
  
```

**Q 3:** Why we need to install VBIOS / UEFI GOP driver without DP support? [ast2600]

In the beginning of platform design, there are some necessary conditions should be satisfied when you want use DP (display port). Some of them are related with BMC FW support. But it usually would cause system hang in the early stage of system booting, if your platform would not be satisfied the minimum system request. To install the VBIOS / UEFI GOP driver without DP support will make this easier to find out which part of system need to debug.

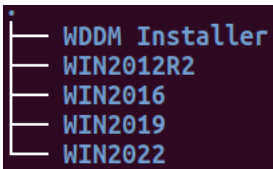
**Q 4:** Why we need BMC firmware for display device? [ast2600]

According [CVE-2019-6260](#) impact, the PCIE VGA P2A(PCI2AHB) bridge is closed from ast2600. The frame buffer initial could not be executed in the VBIOS / UEFI anymore. If customer the BMC firmware is disable or removed from ast2600, then the display function will also be disabled.

## Chapter 4. Windows Driver

In the aspeed series display device are all supported Windows Server version OS. The detail support Windows Server version list will be recorded in the package of Windows driver.

### 4.1 Package List



- WDDM Installer : Microsoft installer package version of Windows display driver.
- WIN2012R2 : Windows display driver of Windows 2012 R2.
- WIN2016 : Windows display driver of Windows 2016.
- WIN2019 : Windows display driver of Windows 2019.
- WIN2022 : Windows display driver of Windows 2022.

### 4.2 Support List

The Windows server version will be supported. These drivers support cycle will also follow Windows product life cycle. Please refer Windows MSDN website for more information.

### 4.3 Installation

User could use the Microsoft Installer Package (.msi) that are located under /WDDM Installer folder for automatic installed into Windows OS. Or use the device manager to install driver binary directly.

### 4.4 Q & A

**Q 1:** Does Windows 10 / 11 are support on ast2600?

The whole Aspeed display controller will be designed to support server usage purpose. In the Windows 10 / 11, the request of display will be more than server version. Unfortunately, our display controller could not be satisfied the minimum request of basic display drive model on Windows 10 / 11.

**Q 2:** Do we still meet code 52 issue when the security boot is turned on?

In the pervious release, we have ever announced that the code 52 error will be occurred when you use Windows with security on. It is caused by how we signed our display driver binary. We



have improved the signed method of our Windows binary. This error code 52 condition should be fixed in our new Windows driver release.

ASPEED

## Chapter 5. Linux Driver

The Direct Rendering Manager (DRM) is a subsystem of the Linux kernel responsible for interfacing with GPUs of modern video cards. DRM exposes an API that user-space programs can use to send commands and data to the GPU and perform operations such as configuring the mode setting of the display.

ASPEED DRM driver implements all of basic features of kernel mode-setting (KMS) which is a subsystem of DRM for software operation that activates a display mode (screen resolution, color depth, and refresh rate) for a computer's display controller.

You can find the ASPEED DRM driver source code which is located at `linux/drivers/gpu/drm/ast` inside of Linux kernel source code. In order to execute the full of our advance features, we suggest you follow the sequence in the bellow to install our device driver for DRM.

Because of the way to maintain linux source code, we can't grantee inbox driver of the linux kernel of the distribution you used contains our latest driver. If you have any problem, we will suggest you try the out-of-box (OOB) from our [website](#) first to see if it can be fixed.

### 5.1 Package List

```
COPYING
DKMS
├── ast-drm-linux5.04.deb
├── ast-drm-linux5.15.deb
├── readme.txt
RPM
├── RPMS
├── SRPMS
├── auto-srpm.sh
├── auto-update.sh
├── readme.txt
├── sign_key
release.txt
sources
├── readme.txt
├── src515
```

- DKMS: The driver folder for Ubuntu distributions.
  - readme.txt How-to for DKMS package usage



- RPM: The folder for RHEL/CentOS distributions.
  - RPMS The binary driver folder for RHEL/CentOS distributions.
  - SRPMS: The source code driver folder for RHEL/CentOS/SUSE distributions.
  - auto-srpm.sh script to install SRPM and rebuilt image per current distribution.
  - auto-update.sh script to install RPM and rebuilt image per current distribution.
  - readme.txt How-to for RPM package usage
- release.txt Release Note. You can find the information of supported distributions and change history here.
- sources Source code per linux kernel

## 5.2 Support List

*Ubuntu/Redhat/OpenSUSE/OpenAnolis* are distributions on our support list. Please be noted that ASPEED only supports the LTS ones. For detailed information, you can refer to the release note in each driver package on our website.

## 5.3 Installation

### ❖ Ubuntu:

```
Run "uname -r" to get the kernel version.  
Disable "secure boot" in BIOS option.  
Select proper deb and run "dpkg -i ast-drm-linux4.15.deb" for example.  
>>> if it is failed due to dependency issue  
>>> run "apt-get -f install" and try again  
# reboot
```

### ❖ RHEL/CentOS:

By auto-update for RPM packages:

**RPM can be installed without other package, but only can be installed in the kernel which is the same kernel vector with the original distribution.**

```
# ./auto-update.sh
```

```
The architecture is x86_64
Check Previous Installation Package ....
Remove Previous Installation Package ....
Install Package on Redhat Distribution ....
Verifying... ##### [100%]
Preparing... ##### [100%]
Updating / installing...
  1:ast-drm-5.14.0-70.13.1.el9_0.x86_##### [100%]
Rebuilt Image ....
Install Package Ready and Please Reoot System!!

>>> boot into the new initial image

# reboot
```

Update Driver by SRPMS: used if cannot find proper RPMs:

Install Build Package. In RHEL, you need to login RHEL certified account, or can not download development tool. RHEL website: <https://www.redhat.com/en>

```
# yum groupinstall "Development Tools" "Development Libraries"
# yum install rpmdevtools
# yum install kernel-devel-$(uname -r)
```

Build and Install SRPM by auto script

```
# ./auto-srpm.sh
>>> Check Previous Installation Package
>>> Remove Previous Installation Package
>>> Rebuild SRPM on RHEL Distribution

Rebuild SRPM on RHEL Distribution ....
Installing ast-drm-1.13-0-rhel90.src.rpm
Executing(%prep): /bin/sh -e /var/tmp/rpm-tmp.noi5yF
+ umask 022
+ cd /root/rpmbuild/BUILD
+ cd /root/rpmbuild/BUILD
+ rm -rf ast-drm-1.13
+ /usr/bin/mkdir -p ast-drm-1.13
+ cd ast-drm-1.13
+ /usr/bin/gzip -dc /root/rpmbuild/SOURCES/ast_src.tar.gz
+ /usr/bin/tar -xvof -

>>> Install Package on RHEL Distribution
```

```
Install Package on RHEL Distribution ....
Verifying... ##### [100%]
Preparing... ##### [100%]
Updating / installing...
  1:ast-drm-1.13-0 ##### [100%]
Rebuilt Image ....
Install Package Ready and Please Reboot System!!
```

```
>>> boot into the new initial image
# reboot
```

#### Build and Install SRPM by manual

```
Build RPMS
# rpmbuild --rebuild ast-drm-1.13.0-rhel84.src.rpm
# reboot
```

#### ❖ SUSE:

Update Driver by SRPMS:

Install Build Package

```
Install Build Package
# zypper -y install kernel-devel
# zypper -y install rpm-build
```

By auto-srpm for SRPM packages:

```
# ./auto-srpm.sh
# reboot
```

#### Build and Install SRPM by manual

```
Build and Install SRPM
#rpmbuild --rebuild ast-drm-[version]-[distribution].src.rpm

Allow un-supported modules
>> set allow_unsupported_modules 0 to 1 in /etc/modprobe.d/10-unsupported-modules.conf
# reboot
```

## 5.4 Q&A

**Q 1:** DRM mode list is limited by the one-twos of VGA memory size

```
Patch: DRI devel - Patchwork
```

Affect Version: Linux kernel 5.6

The flow of mode setting covert to use atomic modesetting. Atomic modesetting requires importing the designated framebuffer into VGA memory before evicting the active one. Hence, the size calculation for each mode has to take double buffering into account.

The new mode memory size requirements are below: 1920x1200x32bpp: 32M byte

1920x1080x32bpp: 32M byte

1680x1050x32bpp: 16M byte

1600x1200x32bpp: 16M byte

1280x1024x32bpp: 16M byte

**Q 2: How to check the current version of ast drivers.**

```
# dmesg | grep drm
```

There are informations for ast drm drivers as below.

```
[swl@localhost ~]$ dmesg | grep drm
[ 1.032662] fb: switching to astdrmfb from EFI VGA
[ 1.032931] ast 0000:02:00.0: [drm] P2A bridge disabled, using default configuration
[ 1.032933] ast 0000:02:00.0: [drm] AST 2600 detected
[ 1.032945] ast 0000:02:00.0: [drm] Using ASPEED DisplayPort transmitter
[ 1.032946] ast 0000:02:00.0: [drm] dram MCLK=800 Mhz type=1 bus_width=16
[ 1.033152] [drm] Initialized ast 1.13.0 20220421 for 0000:02:00.0 on minor 0
[ 1.138080] fbcon: astdrmfb (fb0) is primary device
[ 1.210533] ast 0000:02:00.0: [drm] fb0: astdrmfb frame buffer device
```

Driver name: ast

Driver date: 20220421

Driver major: 1

Driver minor: 13

Driver patch level: 0

**Q 3: The mode list when no connecting physical monitor.**

Linux would show the mode list for standard timing only.

1024x768

800x600

**Q 4: DRM driver may not be enabled.**

Check /etc/default/grub or /etc/sysconfig/grub. Is there paramant, "nomodeset", in GRUB\_LINUX.

>> if yes, remove "nomodeset", then rebuild grub menu:



RHEL/CentOS:

In legacy bios for generating grub.cfg.

```
# grub2-mkconfig -o /boot/grub2/grub.cfg
```

In UEFI mode, for generating grub.cfg.

```
# grub2-mkconfig -o /boot/efi/rhel/grub2/grub.cfg
```

Ubuntu:

In legacy bios for generating grub.cfg.

```
# grub2-mkconfig -o /boot/grub2/grub.cfg
```

In UEFI mode, for generating grub.cfg.

```
# grub2-mkconfig -o /boot/efi/ubuntu/grub2/grub.cfg
```

**Q 5:** Get the connect status with physical monitor.

Get the EDID from monitor.

```
# cat /sys/class/drm/card0-VGA-1/edid | xxd
```

Get the mode list from monitor.

```
# cat /sys/class/drm/card0-VGA-1/modes
```

**Q 6:** Get information of current distribution.

```
# cat /etc/os-release
```

**Q 7:** The incompatible issues of Wayland after the version 40 of gnome.

The default window system on some of distributions may is wayland. Like sles15.4 desktop.

There are incompatible issues after the version 40 of gnome.

We suggest you disable wayland feature on such situations.

```
# Edit file /etc/gdm/custom.conf, and setup "WaylandEnable=false"
```

**Q 8:** Setup the dual-GPU systems.

This feature start from RHEL8.2. reference from the release note of RHEL8.2

[https://access.redhat.com/documentation/en-us/red\\_hat\\_enterprise\\_linux/8/html/8.2\\_release\\_notes/rhel-8-2-0-release#enhancement\\_desktop](https://access.redhat.com/documentation/en-us/red_hat_enterprise_linux/8/html/8.2_release_notes/rhel-8-2-0-release#enhancement_desktop)

Steps:

1. Enable wayland on Gdm

Edit file /etc/gdm/custom.conf

Setup "WaylandEnable=true"

2. Remove the limitation for AST Chip on udev

Comment the define for AST Chip

By editing file, /usr/lib/udev/rules.d/61-gdm.rules.

3. Reboot

Reboot your system to apply the change.

4. Check wayland is enable

```
[swl@localhost ~]$ loginctl show-session 2 -p Type
Type=wayland
```

Below distributions which supported dual-GPU is confirmed by Aspeed.

RHEL 8.2

RHEL 8.4

RHEL 8.6

#### Q 9: DisplayPort no output during OS installation.

This is because ASPEED DRM driver does not support DisplayPort until linux kernel 5.18. If your kernel is not new enough, you can use the DP-FW contained in ASPEED openbmc whose version newer than [v08.03](#). It fixes this problem with limited support resolutions, 800x600/1024x768. You can find the source code of DP-FW from the website below.

[u-boot/aspeed\\_dp.c at aspeed-master-v2019.04](#)

[u-boot/dp\\_mcu\\_firmware.h at aspeed-master-v2019.04](#)