



How to display on HDMI

# How to display on HDMI

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## 1 Article purpose

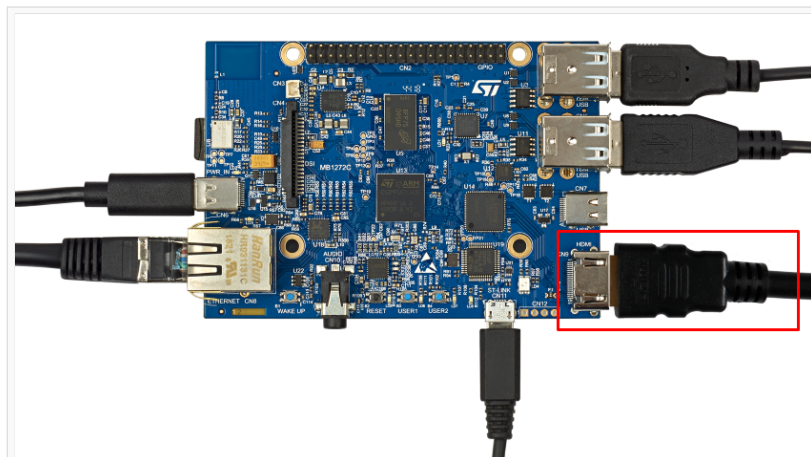
This article aims to specify what is displayed on an HDMI<sup>®</sup>[1] monitor (or TV) connected, through an HDMI cable, to a STMicroelectronics board, in different use cases explained below.

This article also explains how to get the video modes (resolutions and refresh frequencies) of the HDMI monitor (or TV) that are supported by the device, how to test them, and finally how to select one.

## 2 Prerequisites

Obviously, it is mandatory that your STMicroelectronics board has an HDMI connector, which is the case for:

- the STM32MP157x-DKx Discovery kit (CN9 HDMI connector)








HDMI cable connected on Discovery kit  
**STM32MP157C-DK2** shown here (without the MB1407 daughterboard DSI display)

An HDMI cable and an HDMI monitor (or TV) are also needed.

### 3 Use cases

The table below shows the different use cases that involve both the DSI display and the HDMI monitor.

Original situation	Action	Final situation	
		DSI display	HDMI monitor
<p>HDMI unplugged</p> <ul style="list-style-type: none"> <li>- Board <b>not</b> started</li> <li>- DSI display connected</li> <li>- HDMI monitor <b>not</b> connected</li> </ul>	Start the board	 <p>then briefly</p>  <p>and finally</p> 	
<p>HDMI cold-plug</p> <ul style="list-style-type: none"> <li>- Board <b>not</b> started</li> <li>- DSI display connected</li> </ul>	Start the board		 <p>then</p>

Original situation	Action	Final situation	
		DSI display	HDMI monitor
<p>ed</p> <p>- HDMI monitor <b>connected</b></p>			
<p>HDMI hot-plug</p> <p>- Board <b>started</b></p> <p>- DSI display <b>connected</b></p> <p>- HDMI monitor <b>not connected</b></p>	<p>Plug the HDMI monitor</p>		<p>The demo launcher window is not displayed fullscreen</p>
<p>- HDMI monitor <b>connected</b></p>	<p>Tap or click on the top-right corner cross to close the demo launcher window</p> <p>Tap or click on the left-bottom "nine blue square" icon to start again the demo launcher window</p>		<p>The demo launcher window is displayed fullscreen</p>
<p>HDMI hot-unplug</p> <p>- Board <b>started</b></p> <p>- DSI display</p>	<p>Unplug the HDMI monitor</p>	<p>The demo launcher window is not downscaled</p>	

Original situation	Action	Final situation	
		DSI display	HDMI monitor
connected - HDMI monitor <b>connected</b>	Restart Weston <sup>[2]</sup>		

The following statements explain the use cases summarized above:

- The U-Boot graphical console ("ST life.augmented" picture) is never displayed on the HDMI monitor. This console is displayed on the DSI display (if any on the board).
- If the board has both a DSI display and an HDMI monitor, the Wayland background layer is only displayed on one of these displays (see the "rules" below).
- **HDMI unplugged**: if no HDMI monitor is connected to the board before the board starts, and if a DSI display is connected to the board, the Wayland background layer is displayed on the DSI display.
- **HDMI cold-plug**: if an HDMI monitor is connected to the board before the board starts, the Wayland background layer is displayed on this HDMI monitor.
- **HDMI hot-plug**: if an HDMI monitor is connected to the board after the board starts, this plug is automatically detected by Wayland / Weston. The demo launcher window is not automatically upscaled: close and open it again to have it fullscreen on the HDMI monitor.
- **HDMI hot-unplug**: if an HDMI monitor is disconnected from the board while the Wayland background layer is displayed on the HDMI monitor, this unplug is automatically detected by Wayland / Weston. The demo launcher window is not automatically downscaled: restart Weston<sup>[2]</sup> to have it fullscreen on the DSI display.

## 4 Video modes

Generally, the HDMI monitor (or TV) provides several video modes (resolutions and refresh frequencies), that might not be all supported by the platform. In case of **HDMI cold-plug** or **HDMI hot-plug**, the first video mode provided by the HDMI monitor that is supported by the platform, is selected. To change this video mode selected per default, all the video modes both provided by the HDMI monitor and supported by the platform shall be retrieved, optionally tested, and finally set in the *weston.ini* configuration file<sup>[3]</sup>.

Let us assume that the DSI display and the HDMI monitor are connected to the board, and that the Wayland background is displayed on the HDMI monitor.

- Retrieve the video modes provided by the HDMI monitor and supported by the platform thanks to the `modetest` command (see below how to get all the video modes supported by the HDMI monitor, whether they are supported or not by the platform)

```
Board $> modetest -M stm
```



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```

Encoders:
id      crtc    type    possible crtcs  possible clones
28      33      DPI     0x00000001     0x00000000
30      0       DSI     0x00000001     0x00000000

Connectors:
id      encoder status      name          size (mm)      modes  encoders
29      28      connected   HDMI-A-1      700x390       10     28
  modes:
    name refresh (Hz) hdisp hss hse htot vdisp vss vse vtot)
1920x1080 30 1920 2008 2052 2200 1080 1084 1089 1125 74250 flags: phsync, pvsync;
type: driver
1920x1080 25 1920 2448 2492 2640 1080 1084 1089 1125 74250 flags: phsync, pvsync;
type: driver
1920x1080 24 1920 2558 2602 2750 1080 1084 1089 1125 74250 flags: phsync, pvsync;
type: driver
1280x720 60 1280 1390 1430 1650 720 725 730 750 74250 flags: phsync, pvsync; type:
driver
1280x720 60 1280 1390 1430 1650 720 725 730 750 74250 flags: phsync, pvsync; type:
driver
1280x720 50 1280 1720 1760 1980 720 725 730 750 74250 flags: phsync, pvsync; type:
driver
1280x720 50 1280 1720 1760 1980 720 725 730 750 74250 flags: phsync, pvsync; type:
driver
800x600 75 800 816 896 1056 600 601 604 625 49500 flags: phsync, pvsync; type: driver
720x576 50 720 732 796 864 576 581 586 625 27000 flags: nhsync, nvsync; type: driver
720x480 60 720 736 798 858 480 489 495 525 27000 flags: nhsync, nvsync; type: driver
props:
  1 EDID:
    flags: immutable blob
    blobs:
    value:
      00ffffffffffff004c2d920900000000
      0a160103804627780aee91a3544c9926
      0f5054bdef80714f81c0810081809500
      a9c0b3000101023a801871382d40582c
      4500a05a0000001e662156aa51001e30
      468f3300a05a0000001e00000fd0018
      4b0f5117000a20202020202000000fc
      0053414d53554e470a20202020200152
      020330f14d901f041305140312202122
      07162309070783010000e2000f72030c
      001000b82d20d0080140073f405090a0
      011d80d0721c1620102c2580a05a0000
      009e011d8018711c1620582c2500a05a
      0000009e011d00bc52d01e20b8285540
      a05a0000001e011d007251d01e206e28
      5500a05a0000001e000000000000097

  2 DPMS:
    flags: enum
    enums: On=0 Standby=1 Suspend=2 Off=3
    value: 0

  5 link-status:
    flags: enum
    enums: Good=0 Bad=1
    value: 0

  6 non-desktop:
    flags: immutable range
    values: 0 1
    value: 0

  19 CRTC_ID:
    flags: object
    value: 33

31      0       connected   DSI-1         52x86         1         30
  modes:
    name refresh (Hz) hdisp hss hse htot vdisp vss vse vtot)

```



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```
480x800 50 480 600 664 784 800 814 828 842 33000 flags: ; type: preferred, driver
props:
  1 EDID:
    flags: immutable blob
    blobs:
      value:
  2 DPMS:
    flags: enum
    enums: On=0 Standby=1 Suspend=2 Off=3
    value: 3
  5 link-status:
    flags: enum
    enums: Good=0 Bad=1
    value: 0
  6 non-desktop:
    flags: immutable range
    values: 0 1
    value: 0
  19 CRTC_ID:
    flags: object
    value: 0

CRTCs:
id   fb   pos   size
33   39   (0,0) (1280x720)
1280x720 60 1280 1390 1430 1650 720 725 730 750 74250 flags: phsync, pvsync; type:
driver
props:
  20 ACTIVE:
    flags: range
    values: 0 1
    value: 1
  21 MODE_ID:
    flags: blob
    blobs:
      value:
        0a220100000056e05960572060000d002
        d502da02ee0200003c0000000050000000
        40000000313238307837323000000000
        00000000000000000000000000000000
        00000000
  18 OUT_FENCE_PTR:
    flags: range
    values: 0 18446744073709551615
    value: 0
  25 GAMMA_LUT:
    flags: blob
    blobs:
      value:
  26 GAMMA_LUT_SIZE:
    flags: immutable range
    values: 0 4294967295
    value: 256

Planes:
id   crtc   fb   CRTC x,y   x,y   gamma size   possible crtcs
32   33     39   0,0       0,0   0           0             0x00000001
formats: AR24 XR24 RG24 RG16 AR15 XR15 AR12 XR12 C8
props:
  7 type:
    flags: immutable enum
    enums: Overlay=0 Primary=1 Cursor=2
    value: 1
  16 FB_ID:
```



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```

    flags: object
    value: 39
17 IN_FENCE_FD:
    flags: signed range
    values: -1 2147483647
    value: -1
19 CRTC_ID:
    flags: object
    value: 33
12 CRTC_X:
    flags: signed range
    values: -2147483648 2147483647
    value: 0
13 CRTC_Y:
    flags: signed range
    values: -2147483648 2147483647
    value: 0
14 CRTC_W:
    flags: range
    values: 0 2147483647
    value: 1280
15 CRTC_H:
    flags: range
    values: 0 2147483647
    value: 720
8 SRC_X:
    flags: range
    values: 0 4294967295
    value: 0
9 SRC_Y:
    flags: range
    values: 0 4294967295
    value: 0
10 SRC_W:
    flags: range
    values: 0 4294967295
    value: 83886080
11 SRC_H:
    flags: range
    values: 0 4294967295
    value: 47185920
34 0 0 0,0 0,0 0 0x00000001
formats: AR24 RG24 RG16 AR15 AR12 C8
props:
7 type:
    flags: immutable enum
    enums: Overlay=0 Primary=1 Cursor=2
    value: 0
16 FB_ID:
    flags: object
    value: 0
17 IN_FENCE_FD:
    flags: signed range
    values: -1 2147483647
    value: -1
19 CRTC_ID:
    flags: object
    value: 0
12 CRTC_X:
    flags: signed range
    values: -2147483648 2147483647
    value: 0
13 CRTC_Y:
    flags: signed range
    values: -2147483648 2147483647
    value: 0
14 CRTC_W:
```



```

                flags: range
                values: 0 2147483647
                value: 0
15 CRTC_H:
                flags: range
                values: 0 2147483647
                value: 0
8 SRC_X:
                flags: range
                values: 0 4294967295
                value: 0
9 SRC_Y:
                flags: range
                values: 0 4294967295
                value: 0
10 SRC_W:
                flags: range
                values: 0 4294967295
                value: 0
11 SRC_H:
                flags: range
                values: 0 4294967295
                value: 0

Frame buffers:
id      size  pitch

```

- Analyse the output of the *modetest* command:
  - 10 modes (8 unique modes) of the **connected** HDMI monitor (**HDMI-A-1** / connector **29**) are supported:
    - 1920x1080** resolution with a refresh frequency of **30** Hz
    - 1920x1080** resolution with a refresh frequency of **25** Hz
    - 1920x1080** resolution with a refresh frequency of **24** Hz
    - 1280x720** resolution with a refresh frequency of **60** Hz
    - 1280x720** resolution with a refresh frequency of **50** Hz
    - 800x600** resolution with a refresh frequency of **75** Hz
    - 720x576** resolution with a refresh frequency of **50** Hz
    - 720x480** resolution with a refresh frequency of **60** Hz



**In the above example, some 1920x1080 resolutions are available but use cases may not work properly if the platform is not powerful enough for such high resolutions (DDR size and bandwidth, CPU and GPU performances...).**

```

Connectors:
id  encoder status      name          size (mm)    modes  encoders
29  28      connected  HDMI-A-1    700x390     10     28
modes:
name refresh (Hz) hdisp hss hse htot vdisp vss vse vtot)
1920x1080 30 1920 2008 2052 2200 1080 1084 1089 1125 74250 flags: phsync, pvsync;
type: driver
1920x1080 25 1920 2448 2492 2640 1080 1084 1089 1125 74250 flags: phsync, pvsync;
type: driver
1920x1080 24 1920 2558 2602 2750 1080 1084 1089 1125 74250 flags: phsync, pvsync;
type: driver
1280x720 60 1280 1390 1430 1650 720 725 730 750 74250 flags: phsync, pvsync; type:
driver
1280x720 60 1280 1390 1430 1650 720 725 730 750 74250 flags: phsync, pvsync; type:
driver # duplicated mode, depends on hdmi tv

```



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```

1280x720 50 1280 1720 1760 1980 720 725 730 750 74250 flags: phsync, pvsync; type:
driver
1280x720 50 1280 1720 1760 1980 720 725 730 750 74250 flags: phsync, pvsync; type:
driver # duplicated mode, depends on hdmi tv
800x600 75 800 816 896 1056 600 601 604 625 49500 flags: phsync, pvsync; type: driver
720x576 50 720 732 796 864 576 581 586 625 27000 flags: nhsync, nvsync; type: driver
720x480 60 720 736 798 858 480 489 495 525 27000 flags: nhsync, nvsync; type: driver

```

- 1 mode of the **connected** DSI display (**DSI-1** / connector **31**) is supported
  - **480x800** resolution with a refresh frequency of **50** Hz

```

Connectors:
id      encoder status      name      size (mm)      modes      encoders
[...]
```

id	encoder	status	name	size (mm)	modes	encoders
<b>31</b>	0	<b>connected</b>	<b>DSI-1</b>	52x86	1	30

```

modes:
name refresh (Hz) hdisp hss hse htot vdisp vss vse vtot)
480x800 50 50 480 600 664 784 800 814 828 842 33000 flags: ; type: preferred, driver

```

- Per default, the first video mode provided by the HDMI monitor that is supported by the platform, is selected: here, it is the **1280x720 60** resolution
  - Check it with the information provided by the *modetest* command: make the link between the HDMI connector **29**, the encoder id **28**, the CRTC id **33**, and finally the video mode **1280x720 60**

```

Connectors:
id      encoder status      name      size (mm)      modes      encoders
29    28    connected      HDMI-A-1      710x400      3          27

Encoders:
id      crtc   type      possible crtcs  possible clones
28    33    DPI      0x00000001     0x00000000

```

```

CRTCs:
id      fb      pos      size
33    39      (0,0)    (1280x720)
1280x720 60 1280 1390 1430 1650 720 725 730 750 74250 flags: phsync, pvsync; type:
driver

```

- Stop Weston<sup>[2]</sup>, use the *modetest* command<sup>[4]</sup> to test the different modes, and restart Weston<sup>[2]</sup>

Syntax:

```
Board $> modetest -M stm -s <HDMI connector>:<selected resolution> -v
```

Example with the 8 modes identified above:

```

Board $> systemctl stop weston
Board $> modetest -M stm -s 29:1920x1080-30 -v
Board $> modetest -M stm -s 29:1920x1080-25 -v
Board $> modetest -M stm -s 29:1920x1080-24 -v
Board $> modetest -M stm -s 29:1280x720-60 -v # -60 to specify the Hz as there are
two 1280x720 modes
Board $> modetest -M stm -s 29:1280x720-50 -v # -50 to specify the Hz as there are

```



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```
two 1280x720 modes
Board $> modetest -M stm -s 29:800x600 -v
Board $> modetest -M stm -s 29:720x480 -v
Board $> modetest -M stm -s 29:720x576 -v
Board $> systemctl start weston
```

- Set the selected video mode in the `/etc/xdg/weston/weston.ini` configuration file, and restart Weston<sup>[2]</sup>

Syntax:

```
[output]
name=HDMI-A-1
mode=<selected resolution>
```

Example (720x480 resolution selected):

```
mode=720x480
```

```
Board $> systemctl restart weston
```

- Check that the new video mode has been taken into account with the information provided by the `modetest` command: make the link between the HDMI connector 29, the encoder id 28, the CRTC id 33, and finally the new video mode 720x480

```
Board $> modetest -M stm
```

```
Encoders:
id      crtc   type   possible crtcs  possible clones
28      33      DPI    0x00000001     0x00000000
```

```
Connectors:
id      encoder status      name          size (mm)    modes  encoders
29      28      connected   HDMI-A-1     700x390     10     28
```

```
CRTCs:
id      fb      pos      size
33      35      (0,0)    (720x480)
720x480 60 720 736 798 858 480 489 495 525 27000 flags: nhsync, nvsync; type: driver
```

## 5 FAQ

### 5.1 How to get all the video modes supported by the HDMI monitor

This chapter gives a method to retrieve **all the video modes supported by the HDMI monitor**, whether they are supported or not by the platform.

- Retrieve all the video modes supported by the HDMI monitor

```
Board $> dmesg -C
Board $> echo 4 > /sys/module/drm/parameters/debug
Board $> systemctl restart weston
Board $> dmesg
```

```
[ 2527.787272] [drm:drm_helper_probe_single_connector_modes] [CONNECTOR:29:HDMI-A-1]
[ 2527.825480] [drm:drm_add_display_info] non_desktop set to 0
[ 2527.825502] [drm:drm_add_display_info] HDMI: DVI dual 0, max TMDS clock 225000 kHz
[ 2527.825551] [drm:drm_add_edid_modes.part.19] ELD monitor SAMSUNG
[ 2527.825569] [drm:drm_add_edid_modes.part.19] HDMI: latency present 0 0, video
latency 208 1, audio latency 8 64
[ 2527.825580] [drm:drm_add_edid_modes.part.19] ELD size 32, SAD count 1
[ 2527.825591] [drm:drm_add_display_info] non_desktop set to 0
[ 2527.825601] [drm:drm_add_display_info] HDMI: DVI dual 0, max TMDS clock 225000 kHz
[ 2527.828842] [drm:drm_mode_debug_printmodeline] Modeline 36:"1920x1080" 60 148500
1920 2008 2052 2200 1080 1084 1089 1125 0x48 0x5
[ 2527.828863] [drm:drm_mode_prune_invalid] Not using 1920x1080 mode: CLOCK_HIGH
[ 2527.828888] [drm:drm_mode_debug_printmodeline] Modeline 39:"1366x768" 60 85500 1366
1436 1579 1792 768 771 774 798 0x40 0x5
[ 2527.828901] [drm:drm_mode_prune_invalid] Not using 1366x768 mode: CLOCK_RANGE
[ 2527.828922] [drm:drm_mode_debug_printmodeline] Modeline 40:"1920x1080i" 50 74250
1920 2448 2492 2640 1080 1084 1094 1125 0x40 0x15
[ 2527.828934] [drm:drm_mode_prune_invalid] Not using 1920x1080i mode: NO_INTERLACE
[ 2527.828955] [drm:drm_mode_debug_printmodeline] Modeline 41:"1920x1080i" 60 74250
1920 2008 2052 2200 1080 1084 1094 1125 0x40 0x15
[ 2527.828967] [drm:drm_mode_prune_invalid] Not using 1920x1080i mode: NO_INTERLACE
[ 2527.828987] [drm:drm_mode_debug_printmodeline] Modeline 46:"1152x864" 0 108000 1152
1216 1344 1600 864 865 868 900 0x40 0x5
[ 2527.828999] [drm:drm_mode_prune_invalid] Not using 1152x864 mode: CLOCK_HIGH
[ 2527.829019] [drm:drm_mode_debug_printmodeline] Modeline 47:"1280x800" 0 71000 1280
1328 1360 1440 800 803 809 823 0x40 0x9
[ 2527.829039] [drm:drm_mode_prune_invalid] Not using 1280x800 mode: CLOCK_RANGE
[ 2527.829059] [drm:drm_mode_debug_printmodeline] Modeline 48:"1280x1024" 0 108000
1280 1328 1440 1688 1024 1025 1028 1066 0x40 0x5
[ 2527.829071] [drm:drm_mode_prune_invalid] Not using 1280x1024 mode: CLOCK_HIGH
[ 2527.829091] [drm:drm_mode_debug_printmodeline] Modeline 49:"1440x900" 0 88750 1440
1488 1520 1600 900 903 909 926 0x40 0x9
[ 2527.829103] [drm:drm_mode_prune_invalid] Not using 1440x900 mode: CLOCK_RANGE
[ 2527.829123] [drm:drm_mode_debug_printmodeline] Modeline 50:"1600x900" 0 108000 1600
1624 1704 1800 900 901 904 1000 0x40 0x5
[ 2527.829135] [drm:drm_mode_prune_invalid] Not using 1600x900 mode: CLOCK_HIGH
[ 2527.829155] [drm:drm_mode_debug_printmodeline] Modeline 51:"1680x1050" 0 119000
1680 1728 1760 1840 1050 1053 1059 1080 0x40 0x9
[ 2527.829167] [drm:drm_mode_prune_invalid] Not using 1680x1050 mode: CLOCK_HIGH
[ 2527.829188] [drm:drm_mode_debug_printmodeline] Modeline 52:"800x600" 0 40000 800
```



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```
840 968 1056 600 601 605 628 0x40 0x5
[ 2527.829199] [drm:drm_mode_prune_invalid] Not using 800x600 mode: CLOCK_RANGE
[ 2527.829220] [drm:drm_mode_debug_printmodeline] Modeline 53:"640x480" 0 31500 640
656 720 840 480 481 484 500 0x40 0xa
[ 2527.829231] [drm:drm_mode_prune_invalid] Not using 640x480 mode: CLOCK_RANGE
[ 2527.829253] [drm:drm_mode_debug_printmodeline] Modeline 54:"640x480" 0 31500 640
664 704 832 480 489 492 520 0x40 0xa
[ 2527.829265] [drm:drm_mode_prune_invalid] Not using 640x480 mode: CLOCK_RANGE
[ 2527.829287] [drm:drm_mode_debug_printmodeline] Modeline 55:"640x480" 0 30240 640
704 768 864 480 483 486 525 0x40 0xa
[ 2527.829298] [drm:drm_mode_prune_invalid] Not using 640x480 mode: CLOCK_RANGE
[ 2527.829318] [drm:drm_mode_debug_printmodeline] Modeline 56:"640x480" 0 25175 640
656 752 800 480 490 492 525 0x40 0xa
[ 2527.829330] [drm:drm_mode_prune_invalid] Not using 640x480 mode: CLOCK_RANGE
[ 2527.829350] [drm:drm_mode_debug_printmodeline] Modeline 57:"720x400" 0 28320 720
738 846 900 400 412 414 449 0x40 0x6
[ 2527.829372] [drm:drm_mode_prune_invalid] Not using 720x400 mode: CLOCK_RANGE
[ 2527.829393] [drm:drm_mode_debug_printmodeline] Modeline 58:"1280x1024" 0 135000
1280 1296 1440 1688 1024 1025 1028 1066 0x40 0x5
[ 2527.829404] [drm:drm_mode_prune_invalid] Not using 1280x1024 mode: CLOCK_HIGH
[ 2527.829424] [drm:drm_mode_debug_printmodeline] Modeline 59:"1024x768" 0 78750 1024
1040 1136 1312 768 769 772 800 0x40 0x5
[ 2527.829436] [drm:drm_mode_prune_invalid] Not using 1024x768 mode: CLOCK_RANGE
[ 2527.829457] [drm:drm_mode_debug_printmodeline] Modeline 60:"1024x768" 0 75000 1024
1048 1184 1328 768 771 777 806 0x40 0xa
[ 2527.829469] [drm:drm_mode_prune_invalid] Not using 1024x768 mode: CLOCK_RANGE
[ 2527.829489] [drm:drm_mode_debug_printmodeline] Modeline 61:"1024x768" 0 65000 1024
1048 1184 1344 768 771 777 806 0x40 0xa
[ 2527.829501] [drm:drm_mode_prune_invalid] Not using 1024x768 mode: CLOCK_RANGE
[ 2527.829521] [drm:drm_mode_debug_printmodeline] Modeline 62:"832x624" 0 57284 832
864 928 1152 624 625 628 667 0x40 0xa
[ 2527.829533] [drm:drm_mode_prune_invalid] Not using 832x624 mode: CLOCK_RANGE
[ 2527.829553] [drm:drm_mode_debug_printmodeline] Modeline 65:"800x600" 0 50000 800
856 976 1040 600 637 643 666 0x40 0x5
[ 2527.829564] [drm:drm_mode_prune_invalid] Not using 800x600 mode: CLOCK_RANGE
[ 2527.829585] [drm:drm_mode_debug_printmodeline] Modeline 67:"1920x1080" 0 148500
1920 2008 2052 2200 1080 1084 1089 1125 0x40 0x5
[ 2527.829596] [drm:drm_mode_prune_invalid] Not using 1920x1080 mode: CLOCK_HIGH
[ 2527.829617] [drm:drm_mode_debug_printmodeline] Modeline 70:"1920x1080" 0 148500
1920 2448 2492 2640 1080 1084 1089 1125 0x40 0x5
[ 2527.829629] [drm:drm_mode_prune_invalid] Not using 1920x1080 mode: CLOCK_HIGH
[ 2527.829649] [drm:drm_mode_debug_printmodeline] Modeline 78:"1920x1080i" 0 74250
1920 2008 2052 2200 1080 1084 1094 1125 0x40 0x15
[ 2527.829661] [drm:drm_mode_prune_invalid] Not using 1920x1080i mode: NO_INTERLACE
[ 2527.829690] [drm:drm_mode_debug_printmodeline] Modeline 79:"1920x1080i" 0 74250
1920 2448 2492 2640 1080 1084 1094 1125 0x40 0x15
[ 2527.829701] [drm:drm_mode_prune_invalid] Not using 1920x1080i mode: NO_INTERLACE
[ 2527.829722] [drm:drm_mode_debug_printmodeline] Modeline 85:"720x480i" 0 13500 720
739 801 858 480 488 494 525 0x40 0x101a
[ 2527.829733] [drm:drm_mode_prune_invalid] Not using 720x480i mode: NO_INTERLACE
[ 2527.829754] [drm:drm_mode_debug_printmodeline] Modeline 86:"720x576i" 0 13500 720
732 795 864 576 580 586 625 0x40 0x101a
[ 2527.829765] [drm:drm_mode_prune_invalid] Not using 720x576i mode: NO_INTERLACE
[ 2527.829787] [drm:drm_mode_debug_printmodeline] Modeline 87:"1920x1080i" 50 74250
1920 2448 2492 2640 1080 1084 1094 1125 0x40 0x20015
[ 2527.829799] [drm:drm_mode_prune_invalid] Not using 1920x1080i mode: NO_INTERLACE
[ 2527.829820] [drm:drm_mode_debug_printmodeline] Modeline 88:"1920x1080i" 60 74250
1920 2008 2052 2200 1080 1084 1094 1125 0x40 0x20015
[ 2527.829832] [drm:drm_mode_prune_invalid] Not using 1920x1080i mode: NO_INTERLACE
[ 2527.829853] [drm:drm_mode_debug_printmodeline] Modeline 89:"1280x720" 50 74250 1280
1720 1760 1980 720 725 730 750 0x40 0x1c005
[ 2527.829865] [drm:drm_mode_prune_invalid] Not using 1280x720 mode: NO_STEREO
[ 2527.829885] [drm:drm_mode_debug_printmodeline] Modeline 90:"1280x720" 50 74250 1280
1720 1760 1980 720 725 730 750 0x40 0x4005
[ 2527.829897] [drm:drm_mode_prune_invalid] Not using 1280x720 mode: NO_STEREO
[ 2527.829917] [drm:drm_mode_debug_printmodeline] Modeline 91:"1280x720" 60 74250 1280
1390 1430 1650 720 725 730 750 0x40 0x1c005
```



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```
[ 2527.829929] [drm:drm_mode_prune_invalid] Not using 1280x720 mode: NO_STEREO
[ 2527.829950] [drm:drm_mode_debug_printmodeline] Modeline 92:"1280x720" 60 74250 1280
1390 1430 1650 720 725 730 750 0x40 0x4005
[ 2527.829961] [drm:drm_mode_prune_invalid] Not using 1280x720 mode: NO_STEREO
[ 2527.829982] [drm:drm_mode_debug_printmodeline] Modeline 93:"1280x720" 0 74250 1280
1390 1430 1650 720 725 730 750 0x40 0x1c005
[ 2527.830003] [drm:drm_mode_prune_invalid] Not using 1280x720 mode: NO_STEREO
[ 2527.830024] [drm:drm_mode_debug_printmodeline] Modeline 94:"1280x720" 0 74250 1280
1390 1430 1650 720 725 730 750 0x40 0x4005
[ 2527.830035] [drm:drm_mode_prune_invalid] Not using 1280x720 mode: NO_STEREO
[ 2527.830056] [drm:drm_mode_debug_printmodeline] Modeline 95:"1280x720" 0 74250 1280
1720 1760 1980 720 725 730 750 0x40 0x1c005
[ 2527.830068] [drm:drm_mode_prune_invalid] Not using 1280x720 mode: NO_STEREO
[ 2527.830088] [drm:drm_mode_debug_printmodeline] Modeline 96:"1280x720" 0 74250 1280
1720 1760 1980 720 725 730 750 0x40 0x4005
[ 2527.830099] [drm:drm_mode_prune_invalid] Not using 1280x720 mode: NO_STEREO
[ 2527.830120] [drm:drm_mode_debug_printmodeline] Modeline 97:"1920x1080i" 0 74250
1920 2008 2052 2200 1080 1084 1094 1125 0x40 0x20015
[ 2527.830131] [drm:drm_mode_prune_invalid] Not using 1920x1080i mode: NO_INTERLACE
[ 2527.830152] [drm:drm_mode_debug_printmodeline] Modeline 98:"1920x1080i" 0 74250
1920 2448 2492 2640 1080 1084 1094 1125 0x40 0x20015
[ 2527.830164] [drm:drm_mode_prune_invalid] Not using 1920x1080i mode: NO_INTERLACE
[ 2527.830185] [drm:drm_mode_debug_printmodeline] Modeline 99:"1920x1080" 0 74250 1920
2558 2602 2750 1080 1084 1089 1125 0x40 0x1c005
[ 2527.830196] [drm:drm_mode_prune_invalid] Not using 1920x1080 mode: NO_STEREO
[ 2527.830217] [drm:drm_mode_debug_printmodeline] Modeline 100:"1920x1080" 0 74250
1920 2558 2602 2750 1080 1084 1089 1125 0x40 0x4005
[ 2527.830229] [drm:drm_mode_prune_invalid] Not using 1920x1080 mode: NO_STEREO
[ 2527.830250] [drm:drm_mode_debug_printmodeline] Modeline 101:"1920x1080" 0 148500
1920 2008 2052 2200 1080 1084 1089 1125 0x40 0x1c005
[ 2527.830261] [drm:drm_mode_prune_invalid] Not using 1920x1080 mode: NO_STEREO
[ 2527.830282] [drm:drm_mode_debug_printmodeline] Modeline 102:"1920x1080" 0 148500
1920 2008 2052 2200 1080 1084 1089 1125 0x40 0x20005
[ 2527.830293] [drm:drm_mode_prune_invalid] Not using 1920x1080 mode: NO_STEREO
[ 2527.830322] [drm:drm_mode_debug_printmodeline] Modeline 103:"1920x1080" 0 148500
1920 2448 2492 2640 1080 1084 1089 1125 0x40 0x1c005
[ 2527.830334] [drm:drm_mode_prune_invalid] Not using 1920x1080 mode: NO_STEREO
[ 2527.830355] [drm:drm_mode_debug_printmodeline] Modeline 104:"1920x1080" 0 148500
1920 2448 2492 2640 1080 1084 1089 1125 0x40 0x20005
[ 2527.830366] [drm:drm_mode_prune_invalid] Not using 1920x1080 mode: NO_STEREO
[ 2527.830387] [drm:drm_mode_debug_printmodeline] Modeline 106:"1280x720" 0 74250 1280
1390 1430 1650 720 725 730 750 0x40 0x20005
[ 2527.830399] [drm:drm_mode_prune_invalid] Not using 1280x720 mode: NO_STEREO
[ 2527.830419] [drm:drm_mode_debug_printmodeline] Modeline 108:"1280x720" 0 74250 1280
1720 1760 1980 720 725 730 750 0x40 0x20005
[ 2527.830431] [drm:drm_mode_prune_invalid] Not using 1280x720 mode: NO_STEREO
[ 2527.830452] [drm:drm_mode_debug_printmodeline] Modeline 109:"1920x1080i" 0 74250
1920 2008 2052 2200 1080 1084 1094 1125 0x40 0x1c015
[ 2527.830463] [drm:drm_mode_prune_invalid] Not using 1920x1080i mode: NO_INTERLACE
[ 2527.830484] [drm:drm_mode_debug_printmodeline] Modeline 111:"1920x1080i" 0 74250
1920 2448 2492 2640 1080 1084 1094 1125 0x40 0x1c015
[ 2527.830496] [drm:drm_mode_prune_invalid] Not using 1920x1080i mode: NO_INTERLACE
[ 2527.830517] [drm:drm_mode_debug_printmodeline] Modeline 114:"1920x1080" 0 74250
1920 2558 2602 2750 1080 1084 1089 1125 0x40 0x20005
[ 2527.830528] [drm:drm_mode_prune_invalid] Not using 1920x1080 mode: NO_STEREO
[ 2527.830549] [drm:drm_mode_debug_printmodeline] Modeline 115:"1920x1080" 0 74250
1920 2448 2492 2640 1080 1084 1089 1125 0x40 0x1c005
[ 2527.830561] [drm:drm_mode_prune_invalid] Not using 1920x1080 mode: NO_STEREO
[ 2527.830582] [drm:drm_mode_debug_printmodeline] Modeline 116:"1920x1080" 0 74250
1920 2448 2492 2640 1080 1084 1089 1125 0x40 0x20005
[ 2527.830593] [drm:drm_mode_prune_invalid] Not using 1920x1080 mode: NO_STEREO
[ 2527.830614] [drm:drm_mode_debug_printmodeline] Modeline 117:"1920x1080" 0 74250
1920 2008 2052 2200 1080 1084 1089 1125 0x40 0x1c005
[ 2527.830625] [drm:drm_mode_prune_invalid] Not using 1920x1080 mode: NO_STEREO
[ 2527.830646] [drm:drm_mode_debug_printmodeline] Modeline 118:"1920x1080" 0 74250
1920 2008 2052 2200 1080 1084 1089 1125 0x40 0x20005
[ 2527.830667] [drm:drm_mode_prune_invalid] Not using 1920x1080 mode: NO_STEREO
```



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```
[ 2527.830688] [drm:drm_mode_debug_printmodeline] Modeline 119:"1920x1080i" 0 74250
1920 2008 2052 2200 1080 1084 1094 1125 0x40 0x4015
[ 2527.830699] [drm:drm_mode_prune_invalid] Not using 1920x1080i mode: NO_INTERLACE
[ 2527.830842] [drm:drm_mode_debug_printmodeline] Modeline 120:"1920x1080i" 0 74250
1920 2448 2492 2640 1080 1084 1094 1125 0x40 0x4015
[ 2527.830854] [drm:drm_mode_prune_invalid] Not using 1920x1080i mode: NO_INTERLACE
[ 2527.830876] [drm:drm_mode_debug_printmodeline] Modeline 121:"1920x1080" 0 74250
1920 2448 2492 2640 1080 1084 1089 1125 0x40 0x4005
[ 2527.830887] [drm:drm_mode_prune_invalid] Not using 1920x1080 mode: NO_STEREO
[ 2527.830908] [drm:drm_mode_debug_printmodeline] Modeline 122:"1920x1080" 0 74250
1920 2008 2052 2200 1080 1084 1089 1125 0x40 0x4005
[ 2527.830919] [drm:drm_mode_prune_invalid] Not using 1920x1080 mode: NO_STEREO
[ 2527.830941] [drm:drm_mode_debug_printmodeline] Modeline 123:"1920x1080" 60 148352
1920 2008 2052 2200 1080 1084 1089 1125 0x40 0x5
[ 2527.830952] [drm:drm_mode_prune_invalid] Not using 1920x1080 mode: CLOCK_HIGH
[ 2527.830973] [drm:drm_mode_debug_printmodeline] Modeline 124:"1920x1080i" 60 74176
1920 2008 2052 2200 1080 1084 1094 1125 0x40 0x15
[ 2527.830985] [drm:drm_mode_prune_invalid] Not using 1920x1080i mode: NO_INTERLACE
[ 2527.831006] [drm:drm_mode_debug_printmodeline] Modeline 125:"1280x720" 60 74176
1280 1390 1430 1650 720 725 730 750 0x40 0x5
[ 2527.831026] [drm:drm_mode_prune_invalid] Not using 1280x720 mode: CLOCK_RANGE
[ 2527.831046] [drm:drm_mode_debug_printmodeline] Modeline 126:"640x480" 60 25200 640
656 752 800 480 490 492 525 0x40 0xa
[ 2527.831058] [drm:drm_mode_prune_invalid] Not using 640x480 mode: CLOCK_RANGE
[ 2527.831078] [drm:drm_mode_debug_printmodeline] Modeline 130:"720x480" 60 27027 720
736 798 858 480 489 495 525 0x40 0xa
[ 2527.831089] [drm:drm_mode_prune_invalid] Not using 720x480 mode: CLOCK_RANGE
[ 2527.831110] [drm:drm_mode_debug_printmodeline] Modeline 131:"1920x1080" 24 74176
1920 2558 2602 2750 1080 1084 1089 1125 0x40 0x5
[ 2527.831122] [drm:drm_mode_prune_invalid] Not using 1920x1080 mode: CLOCK_RANGE
[ 2527.831142] [drm:drm_mode_debug_printmodeline] Modeline 132:"1920x1080" 30 74176
1920 2008 2052 2200 1080 1084 1089 1125 0x40 0x5
[ 2527.831154] [drm:drm_mode_prune_invalid] Not using 1920x1080 mode: CLOCK_RANGE
[ 2527.831174] [drm:drm_mode_debug_printmodeline] Modeline 133:"720x480i" 60 13514 720
739 801 858 480 488 494 525 0x40 0x101a
[ 2527.831186] [drm:drm_mode_prune_invalid] Not using 720x480i mode: NO_INTERLACE
[ 2527.831207] [drm:drm_mode_debug_printmodeline] Modeline 134:"1920x1080i" 60 74176
1920 2008 2052 2200 1080 1084 1094 1125 0x40 0x20015
[ 2527.831218] [drm:drm_mode_prune_invalid] Not using 1920x1080i mode: NO_INTERLACE
[ 2527.831239] [drm:drm_mode_debug_printmodeline] Modeline 135:"1280x720" 60 74176
1280 1390 1430 1650 720 725 730 750 0x40 0x1c005
[ 2527.831251] [drm:drm_mode_prune_invalid] Not using 1280x720 mode: NO_STEREO
[ 2527.831272] [drm:drm_mode_debug_printmodeline] Modeline 136:"1280x720" 60 74176
1280 1390 1430 1650 720 725 730 750 0x40 0x4005
[ 2527.831283] [drm:drm_mode_prune_invalid] Not using 1280x720 mode: NO_STEREO
[ 2527.831304] [drm:drm_mode_debug_printmodeline] Modeline 140:"1920x1080" 24 74176
1920 2558 2602 2750 1080 1084 1089 1125 0x40 0x1c005
[ 2527.831316] [drm:drm_mode_prune_invalid] Not using 1920x1080 mode: NO_STEREO
[ 2527.831337] [drm:drm_mode_debug_printmodeline] Modeline 141:"1920x1080" 24 74176
1920 2558 2602 2750 1080 1084 1089 1125 0x40 0x4005
[ 2527.831357] [drm:drm_mode_prune_invalid] Not using 1920x1080 mode: NO_STEREO
[ 2527.831378] [drm:drm_mode_debug_printmodeline] Modeline 142:"1920x1080" 60 148352
1920 2008 2052 2200 1080 1084 1089 1125 0x40 0x1c005
[ 2527.831390] [drm:drm_mode_prune_invalid] Not using 1920x1080 mode: NO_STEREO
[ 2527.831411] [drm:drm_mode_debug_printmodeline] Modeline 143:"1920x1080" 60 148352
1920 2008 2052 2200 1080 1084 1089 1125 0x40 0x20005
[ 2527.831422] [drm:drm_mode_prune_invalid] Not using 1920x1080 mode: NO_STEREO
[ 2527.831443] [drm:drm_mode_debug_printmodeline] Modeline 145:"1280x720" 60 74176
1280 1390 1430 1650 720 725 730 750 0x40 0x20005
[ 2527.831455] [drm:drm_mode_prune_invalid] Not using 1280x720 mode: NO_STEREO
[ 2527.831476] [drm:drm_mode_debug_printmodeline] Modeline 146:"1920x1080i" 60 74176
1920 2008 2052 2200 1080 1084 1094 1125 0x40 0x1c015
[ 2527.831487] [drm:drm_mode_prune_invalid] Not using 1920x1080i mode: NO_INTERLACE
[ 2527.831509] [drm:drm_mode_debug_printmodeline] Modeline 149:"1920x1080" 24 74176
1920 2558 2602 2750 1080 1084 1089 1125 0x40 0x20005
[ 2527.831521] [drm:drm_mode_prune_invalid] Not using 1920x1080 mode: NO_STEREO
[ 2527.831542] [drm:drm_mode_debug_printmodeline] Modeline 150:"1920x1080" 30 74176
```



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```
1920 2008 2052 2200 1080 1084 1089 1125 0x40 0x1c005
[ 2527.831553] [drm:drm_mode_prune_invalid] Not using 1920x1080 mode: NO_STEREO
[ 2527.831574] [drm:drm_mode_debug_printmodeline] Modeline 151:"1920x1080" 30 74176
1920 2008 2052 2200 1080 1084 1089 1125 0x40 0x20005
[ 2527.831585] [drm:drm_mode_prune_invalid] Not using 1920x1080 mode: NO_STEREO
[ 2527.831605] [drm:drm_mode_debug_printmodeline] Modeline 152:"1920x1080i" 60 74176
1920 2008 2052 2200 1080 1084 1094 1125 0x40 0x4015
[ 2527.831617] [drm:drm_mode_prune_invalid] Not using 1920x1080i mode: NO_INTERLACE
[ 2527.831637] [drm:drm_mode_debug_printmodeline] Modeline 153:"1920x1080" 30 74176
1920 2008 2052 2200 1080 1084 1089 1125 0x40 0x4005
[ 2527.831649] [drm:drm_mode_prune_invalid] Not using 1920x1080 mode: NO_STEREO
[ 2527.831682] [drm:drm_helper_probe_single_connector_modes] [CONNECTOR:29:HDMI-A-1]
probed modes :
[ 2527.831703] [drm:drm_mode_debug_printmodeline] Modeline 76:"1920x1080" 30 74250
1920 2008 2052 2200 1080 1084 1089 1125 0x40 0x5
[ 2527.831731] [drm:drm_mode_debug_printmodeline] Modeline 75:"1920x1080" 25 74250
1920 2448 2492 2640 1080 1084 1089 1125 0x40 0x5
[ 2527.831750] [drm:drm_mode_debug_printmodeline] Modeline 74:"1920x1080" 24 74250
1920 2558 2602 2750 1080 1084 1089 1125 0x40 0x5
[ 2527.831770] [drm:drm_mode_debug_printmodeline] Modeline 45:"1280x720" 60 74250 1280
1390 1430 1650 720 725 730 750 0x40 0x5
[ 2527.831789] [drm:drm_mode_debug_printmodeline] Modeline 68:"1280x720" 60 74250 1280
1390 1430 1650 720 725 730 750 0x40 0x5
[ 2527.831808] [drm:drm_mode_debug_printmodeline] Modeline 44:"1280x720" 50 74250 1280
1720 1760 1980 720 725 730 750 0x40 0x5
[ 2527.831827] [drm:drm_mode_debug_printmodeline] Modeline 69:"1280x720" 50 74250 1280
1720 1760 1980 720 725 730 750 0x40 0x5
[ 2527.831846] [drm:drm_mode_debug_printmodeline] Modeline 63:"800x600" 75 49500 800
816 896 1056 600 601 604 625 0x40 0x5
[ 2527.831865] [drm:drm_mode_debug_printmodeline] Modeline 73:"720x576" 50 27000 720
732 796 864 576 581 586 625 0x40 0xa
[ 2527.831883] [drm:drm_mode_debug_printmodeline] Modeline 72:"720x480" 60 27000 720
736 798 858 480 489 495 525 0x40 0xa
[ 2527.832937] [drm:drm_helper_probe_single_connector_modes] [CONNECTOR:31:DSI-1]
[ 2527.833066] [drm:drm_helper_probe_single_connector_modes] [CONNECTOR:31:DSI-1]
probed modes :
[ 2527.833092] [drm:drm_mode_debug_printmodeline] Modeline 37:"480x800" 50 33000 480
600 664 784 800 814 828 842 0x48 0x0
[ 2528.077108] [drm:drm_mode_addfb2] [FB:36]
[ 2528.945095] [drm:drm_mode_addfb2] [FB:38]
```

- Analyse the *drm* logs
  - The modes of the HDMI monitor (**HDMI-A-1** / connector **29**) that contain one of the following keywords are not supported: **CLOCK\_HIGH**, **CLOCK\_RANGE** and **NO\_INTERLACE**

```
[ 2527.787272] [drm:drm_helper_probe_single_connector_modes] [CONNECTOR:29:HDMI-A-1]
[...]
```

```
[ 2527.828842] [drm:drm_mode_debug_printmodeline] Modeline 36:"1920x1080" 60 148500
1920 2008 2052 2200 1080 1084 1089 1125 0x48 0x5
[ 2527.828863] [drm:drm_mode_prune_invalid] Not using 1920x1080 mode: CLOCK_HIGH
[ 2527.828888] [drm:drm_mode_debug_printmodeline] Modeline 39:"1366x768" 60 85500 1366
1436 1579 1792 768 771 774 798 0x40 0x5
[ 2527.828901] [drm:drm_mode_prune_invalid] Not using 1366x768 mode: CLOCK_RANGE
[ 2527.828922] [drm:drm_mode_debug_printmodeline] Modeline 40:"1920x1080i" 50 74250
1920 2448 2492 2640 1080 1084 1094 1125 0x40 0x15
[ 2527.828934] [drm:drm_mode_prune_invalid] Not using 1920x1080i mode: NO_INTERLACE
```

- The 10 modes of the HDMI monitor (**HDMI-A-1** / connector **29**) that are supported (as analyzed from the *modetest* output), are also seen with these *drm* logs





```
[ 2527.831682] [drm:drm_helper_probe_single_connector_modes] [CONNECTOR:29:HDMI-A-1]
probed modes :
[ 2527.831703] [drm:drm_mode_debug_printmodeline] Modeline 76:"1920x1080" 30 74250
1920 2008 2052 2200 1080 1084 1089 1125 0x40 0x5
[ 2527.831731] [drm:drm_mode_debug_printmodeline] Modeline 75:"1920x1080" 25 74250
1920 2448 2492 2640 1080 1084 1089 1125 0x40 0x5
[ 2527.831750] [drm:drm_mode_debug_printmodeline] Modeline 74:"1920x1080" 24 74250
1920 2558 2602 2750 1080 1084 1089 1125 0x40 0x5
[ 2527.831770] [drm:drm_mode_debug_printmodeline] Modeline 45:"1280x720" 60 74250 1280
1390 1430 1650 720 725 730 750 0x40 0x5
[ 2527.831789] [drm:drm_mode_debug_printmodeline] Modeline 68:"1280x720" 60 74250 1280
1390 1430 1650 720 725 730 750 0x40 0x5
[ 2527.831808] [drm:drm_mode_debug_printmodeline] Modeline 44:"1280x720" 50 74250 1280
1720 1760 1980 720 725 730 750 0x40 0x5
[ 2527.831827] [drm:drm_mode_debug_printmodeline] Modeline 69:"1280x720" 50 74250 1280
1720 1760 1980 720 725 730 750 0x40 0x5
[ 2527.831846] [drm:drm_mode_debug_printmodeline] Modeline 63:"800x600" 75 49500 800
816 896 1056 600 601 604 625 0x40 0x5
[ 2527.831865] [drm:drm_mode_debug_printmodeline] Modeline 73:"720x576" 50 27000 720
732 796 864 576 581 586 625 0x40 0xa
[ 2527.831883] [drm:drm_mode_debug_printmodeline] Modeline 72:"720x480" 60 27000 720
736 798 858 480 489 495 525 0x40 0xa
```

- The only mode of the DSI display (**DSI-1** / connector **31**) that is supported (as analyzed from the *modetest* output), is also seen with these *drm* logs

```
[ 2527.833066] [drm:drm_helper_probe_single_connector_modes] [CONNECTOR:31:DSI-1]
probed modes :
[ 2527.833092] [drm:drm_mode_debug_printmodeline] Modeline 37:"480x800" 50 33000 480
600 664 784 800 814 828 842 0x48 0x0
```

## 6 References

- [HDMI \(High-Definition Multimedia Interface\)](#)
- [2.02.12.22.32.4 How to restart Weston](#)
- [How to configure Weston](#)
- [DRM KMS Overview - Test Vsync](#)

High-Definition Multimedia Interface (HDMI standard)

Display Serial Interface (MIPI® Alliance standard)

Display Pixel Interface (MIPI® Alliance standard)

Extended Display Identification Data (HDMI standard)

Frame Buffer (could be the Kernel framebuffer linked to the display, a GPU framebuffer, an imaging framebuffer...)

Doubledata rate (memory domain)

Central processing unit



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Graphics Processing Units

Digital Visual Interface (Digital Display Working Group)