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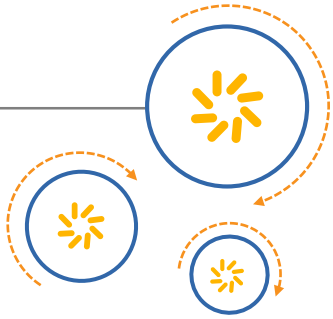

DragonBoard™ 410c based on Qualcomm® Snapdragon™ 410 processor

DSI Display Porting Guide

June 2015

Questions or comments: https://www.96boards.org/DragonBoard410c/forum

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LM80-P0436-4 Rev C

Revision history

Revision	Date	Description
C	June 10, 2015	Miscellaneous updates.
B	May 22, 2015	Updated Revision history and © date.
A	April 22, 2015	Initial release.

Contents

1 Introduction

1.1 Purpose

This document describes how to port the Linux Android display driver for MIPI DSI display panel onto Qualcomm® Snapdragon™ 410 processor using DragonBoard 410c development board. DragonBoard™ 410c has MIPI DSI interface exposed through the high speed Expansion Connector on the board.

1.2 Conventions

Function declarations, function names, type declarations, and code samples appear in a different font, e.g., `#include`.

Code variables appear in angle brackets, e.g., `<number>`.

Commands to be entered appear in a different font, e.g., **`copy a:*.* b:`**.

Button and key names appear in bold font, e.g., click **Save** or press **Enter**.

If you are viewing this document using a color monitor, or if you print this document to a color printer, **red boldface** indicates code that is to be **added**, and ~~blue strikethrough~~ indicates code that is to be replaced or removed.

1.3 Additional information

For additional information, go to https://www.96boards.org/DragonBoard410c/docs.

2 Display Driver Porting Procedures

This chapter describes how to port the DSI driver into the Little Kernel (LK) and the Android kernel.

Section 2.1 provides information on where to download the display driver. Section 2.2 describes how a DTSI and panel file can be manually generated per the XML input parameters from the display vendor. Section 2.3 to Section 2.7 provides instructions for porting the display driver.

NOTE: See the display vendor's specification for driver IC, bridge IC, etc., details before porting.

2.1 Download the display component driver

1. The reference panel driver can be found on the Codeaurora website. Here are the Codeaurora links

   https://www.codeaurora.org/cgit/external/thundersoft/ihvjointlab/gcdb-kernel/tree/display/ — Kernel Space support

   https://www.codeaurora.org/cgit/external/thundersoft/ihvjointlab/gcdb-user-space/tree/display/ — User Space support

   Download the relevant Kernel/User Space driver code patches and apply them in relevant repositories, e.g:

   In Kernel space:

   ```
   cd $ANDROID_BUILD_TOP/kernel
   patch -p1 < 0001-ARM-dts-msm-support-truly-hx8379_a-devicetree.patch
   ```

   In LK Bootloader:

   ```
   cd $ANDROID_BUILD_TOP/ bootable/bootloader/lk
   patch -p1 < 0001-bootloader-lk-add-lcd-truly-hx8379_a.patch
   ```

   NOTE: These are the reference patches. These may not apply directly on all the release code bases at all time. The user will have to resolve the conflicts (see Section 2.6).

2. Obtain the following information in preparation for DSI bringup:
   - Display specification, including parameters.
   - Display power-on sequence and signal duration for GPIO pins, e.g., RESET/IOVDD.
   - DSI initial command sequence and duration information.
   - bitclk, to reach the fps target number.

2.2 Generate DTSI file for kernel and LK

The Global Component Database (GCDB) supported on MSM8916/8016 chipsets allows the panel DTSI and LK panel header file to be generated according to the XML input parameters from the panel vendors.

1. Update the device tree parameters. The GCDB source is located in the `device/qcom/common/display/tools` folder; the device tree parameters detail description is present at `kernel\Documentation\devicetree\bindings\fb\mdss-dsi-panel.txt`.
2. Use the GCDB translate command to generate the DTSI and LK panel header files:

   ```
   perl parser.pl <source xml file OEM edit> panel
   ```

   For example:

   ```
   #perl parser.pl panel_<vendor>_720p_video.xml panel
   ```

   It generates dsi-panel-<vendor>-720p-video.dtsi and panel_<vendor>_720p_video.h files.

2.2.1 Bring up LK

NOTE: It is recommended to first bring up the panel in kernel.

1. Update Android Kernel by copying the panel driver DTSI file to the `kernel/arch/arm64/boot/dts/qcom` folder.
2. Update LK by copying the panel driver header file to the `bootable/bootloader/lk/dev/gcdb/display/include/` folder.
3. Bring up the panel in the Android Kernel.
4. Disable the LK display and the continuous splash display.
   a. To disable the continuous splash display, change DISPLAY_SPLASH_SCREEN to **0** at `bootable/bootloader/lk/target/msm8916/rules.mk`. Then continue to bring up in LK.
   b. Update the target_cont_splash_screen function at `bootable/bootloader/lk/target/msm8916/init.c`.

   For example:

```
static uint8_t splash_override;
/* Returns 1 if target supports continuous splash screen. */
int target_cont_splash_screen()
{
   uint8_t splash_screen = 0;
   if(!splash_override) {
      switch(board_hardware_id())
     {
        case HW_PLATFORM_MTP:
        case HW_PLATFORM_QRD:
           dprintf(SPEW, "Target_cont_splash=1\n");
```

```
                splash_screen = 1; // Change to "0" to disable continous
                                      splash screen
                  break;
                  default:
                dprintf(SPEW, "Target_cont_splash=0\n");
                splash_screen = 0;
            }
        }
        return splash_screen;
      }
```

5. Disable the continuous splash screen at **msm8xxx-cdp.dts** file.

```
&dsi_<vendor>_720p_video{
//      qcom,cont-splash-enabled; // Disable continous splash screen
        }003B
};
```

2.2.2 Input LCD panel parameters in .xml file

Update the .xml file with the panel parameters from the LCD vendor. In the following example, red font indicates the panel parameters to be updated.

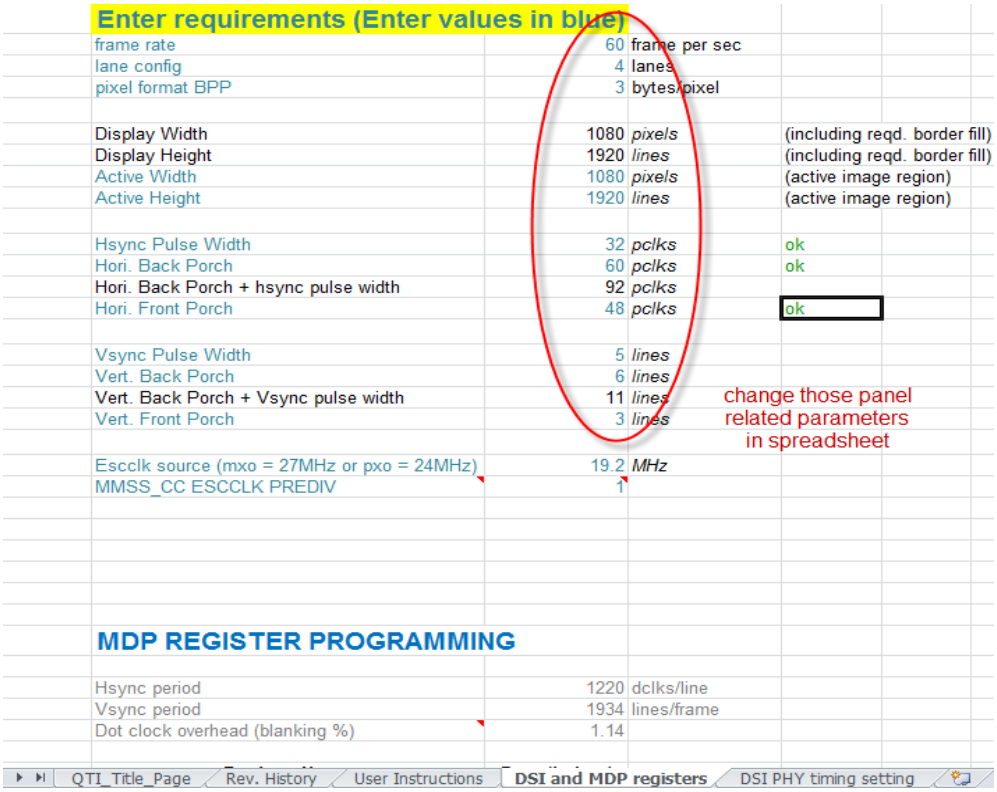
```
   <!-- Panel configuration -->
   <PanelType>0</PanelType> // 0 stands for video mode panel, 1 stands for
command mode panel
   <PanelFrameRate>60</PanelFrameRate>

   <!-- Panel Resolution -->
   <PanelWidth>720</PanelWidth>
   <PanelHeight>1280</PanelHeight>
   <HFrontPorch>140</HFrontPorch>
   <HBackPorch>164</HBackPorch>
   <HPulseWidth>8</HPulseWidth>
   <HSyncSkew>0</HSyncSkew>
   <VBackPorch>4</VBackPorch>
   <VFrontPorch>8</VFrontPorch>
   <VPulseWidth>4</VPulseWidth>

   <!-- Panel Color Information -->
   <ColorFormat>24</ColorFormat> // 24bpp

   <!-- Panel Command information -->
   <OnCommand>"0x29, 0x01, 0x00, 0x00, 0x00, 0x00, 0x02, 0xFF, 0xEE,
              0x29, 0x01, 0x00, 0x00, 0x00, 0x00, 0x02, 0xFB, 0x01,
              … … …
```

```
                0x29, 0x01, 0x00, 0x00, 0x78, 0x00, 0x02, 0x29, 0x00"
</OnCommand> // add your panel on commands from LCD vendor

   <OffCommand>"0x05, 0x01, 0x00, 0x00, 0x32, 0x00, 0x02, 0x28, 0x00,
                … … …
                0x05, 0x01, 0x00, 0x00, 0x78, 0x00, 0x02, 0x10, 0x00"
</OffCommand> // add your panel off commands from LCD vendor

   <OnCommandState>0</OnCommandState> // 0  stands for lp mode
   <OffCommandState>1</OffCommandState> // 1 stands for hs mode

   <!-- Video mode panel information -->
   <HSyncPulse>1</HSyncPulse>
   <BLLPEOFPowerMode>1</BLLPEOFPowerMode>
   <BLLPPowerMode>1</BLLPPowerMode>
   <TrafficMode>2</TrafficMode>

   <!-- Panel Reset Sequence -->
   <ResetSequence>
        <PinState1>1</PinState1>
        <PulseWidth1>20</PulseWidth1>
        <PinState2>0</PinState2>
        <PulseWidth2>2</PulseWidth2>
        <PinState3>1</PinState3>
        <PulseWidth3>20</PulseWidth3>
   </ResetSequence>
```

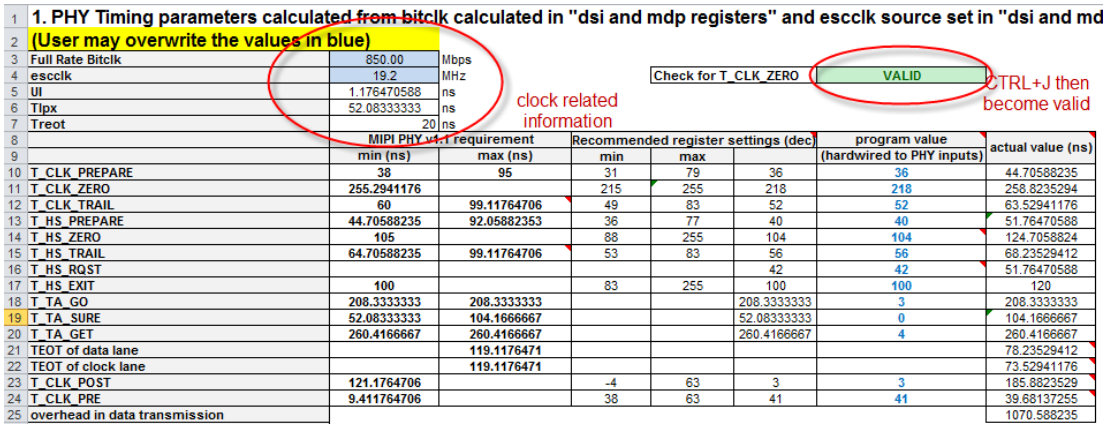
2.2.3 Calculate DSI PHY timings register

The D-PHY auto calculation spreadsheet (click **here** to open the file) is used to calculate the DSI PHY timing settings; this spreadsheet is intended for the MSM8x16 chipset, which uses the DSI6G DSI host design.

1. On the **DSI and MDP registers** worksheet, enter the panel resolution, porch values, fps, color depth, and lane numbers into the fields shown.



2. The DSI-related clock rate is calculated using the **DSI PHY timing setting** worksheet. An invalid value appears in the **Check for T_CLK_ZERO** field. Press **CTRL+J** and **CTRL+K** to recalculate T_CLK_ZERO to a valid value.



The panel requires PHY value setup for bitclk in the DSI PHY register.

2. DSI PHY registers	
PHY Registers (address)	value in hex
DSIPHY_TIMING_CTRL_0 (0xC40)	DA
DSIPHY_TIMING_CTRL_1 (0xC44)	34
DSIPHY_TIMING_CTRL_2 (0xC48)	24
DSIPHY_TIMING_CTRL_3 (0xC4C)	0
DSIPHY_TIMING_CTRL_4 (0xC50)	64
DSIPHY_TIMING_CTRL_5 (0xC54)	68
DSIPHY_TIMING_CTRL_6 (0xC58)	28
DSIPHY_TIMING_CTRL_7 (0xC5C)	38
DSIPHY_TIMING_CTRL_8 (0xC60)	2A
DSIPHY_TIMING_CTRL_9 (0xC64)	3
DSIPHY_TIMING_CTRL_10 (0xC68)	4

3. Input the panel timings value in the .xml file.

```
<!-- Panel Timing -->
<PanelTimings>"0xDA, 0x34, 0x24, 0x00, 0x64, 0x68,
              0x28, 0x38, 0x2A, 0x03, 0x04, 0x00"</PanelTimings>
<TClkPost>0x03</TClkPost>
<TClkPre>0x41</TClkPre>
```

NOTE: DSIPHY_TIMING_CTRL_3 is 0x00. DSIPHY_TIMING_CTRL_11 is used for the DSI secondary display; it is not necessary to modify it if there is no DSI secondary panel.

2.2.3.1 Set DSI clock to HS mode

Certain panels must be set to force_clk_lane_hs to send commands in HS mode.

At `kernel/drivers/video/msm/mdss/mdss_dsi.c` file, on mdss_dsi_onfunction.

For example,

```
mipi->force_clk_lane_hs= 1;
if(mipi->force_clk_lane_hs)
{
u32tmp;
tmp= MIPI_INP((ctrl_pdata->ctrl_base) + 0xac);
tmp|= (1<<28);
MIPI_OUTP((ctrl_pdata->ctrl_base) + 0xac, tmp);
wmb();
}
```

2.3 Input backlight control parameters

Three methods used to control backlight are:

- “bl_ctrl_pwm” = Backlight controlled by PWM GPIO
- “bl_ctrl_wled” = Backlight controlled by WLED

- "bl_ctrl_dcs" = Backlight control by DCS commands

If WLED is used to control the backlight, input the backlight parameters in the .xml file:

```
<!-- Backlight -->
<BLInterfaceType>1</BLInterfaceType>
<BLMinLevel>1</BLMinLevel>
<BLMaxLevel>4095</BLMaxLevel>
<BLStep>100</BLStep>
<BLPMICModel>"PMIC_8xxx"</BLPMICModel>
<BLPMICControlType>1</BLPMICControlType> // 1 stands for Backlight
controlled by WLED.
```

The DCS backlight control is selected at the panel side. The backlight control is highly related to hardware configuration/schematics. If the backlight uses a third-party backlight driver IC, or the schematics is changed from the QTI reference schematics, modify the software to add backlight control routines. The default backlight entry function is used in mdss_fb.c (do not modify).

2.4 Set up DSI panel-related GPIO pins

1. Input GPIO pins parameter in **platform-8xxx.xml** file.

   The information about setting up DSI panel-related GPIO reset pins can be found at `arch/arm/boot/dts/qcom/msm8xxx-mdss.dts`. The GPIO parameters are entered in the .xml file at `device/qcom/common/display/tools/platform-8xxx.xml`.

   For example,

```
<PlatformId>"msm8xxx"</PlatformId>
<!-- GPIO configuration -->
<ResetGPIO>
     <PinSource>"msmgpio"</PinSource>
     <PinId>25</PinId>
     <PinStrength>3</PinStrength>
     <PinDirection>1</PinDirection>
     <PinPull>0</PinPull>
     <PinState>1</PinState>
</ResetGPIO>

<EnableGPIO>
     <PinSource>"msmgpio"</PinSource>
     <PinId>32</PinId>
     <PinStrength>3</PinStrength>
     <PinDirection>1</PinDirection>
     <PinPull>0</PinPull>
     <PinState>1</PinState>
```

For the TE GPIO and backlight GPIO using DCS backlight control, see the platform MDSS DSI parameters description at `kernel/Documentation/devicetree/bindings/fb/mdss-dsi-ctrl.txt`.

For pin definitions, see the parameter details at `/arch/arm/boot/dts/qcom/msm8xxx-pinctrl.dtsi`.

Any LCD module-specific reset sequences beyond QTI's default release software should be handled by the QEM. In general, the default release software should cover most use cases.

2.5 Add the panel device tree to the platform DTS file

Modify the msm8xxx-qrd.dts at `arch/arm/boot/dts/qcom/` by adding the panel device tree.

For example,

```
/include/ "dsi-panel-<vendor>-720p-video.dtsi"

&mdss_mdp {
   qcom,mdss-pref-prim-intf = "dsi";
};

&mdss_pinmux {
                  qcom,num-grp-pins = <3>;
                  qcom,pins = <&gp 32>, <&gp 25>, <&gp 97>;
};

&mdss_dsi0 {
   qcom,dsi-pref-prim-pan = <&dsi_<vendor>_720p_video>;
   pinctrl-names = "default", "sleep";
   pinctrl-0 = <&mdss_dsi_active>;
   pinctrl-1 = <&mdss_dsi_suspend>;
```

2.6 Add panel driver header file and detect panel ID in LK

1. Add the panel header file to `bootable/bootloader/lk/target/msm8xxx/oem_panel.c`.

   For example,

   ```
   #include "include/panel_toshiba_720p_video.h"
   #include "include/panel_nt35590_720p_video.h"
   #include "include/panel_nt35590_720p_cmd.h"
   #include "include/panel_hx8394a_720p_video.h"
   +#include "include/panel_nt35521_720p_video.h"
   ```

2. Add the <vendor>_<resolution>_VIDEO_PANEL parameter to the enum.

   ```
   enum {
   ```

```
TOSHIBA_720P_VIDEO_PANEL,
NT35590_720P_CMD_PANEL,
NT35590_720P_VIDEO_PANEL,
HX8394A_720P_VIDEO_PANEL,
+NT35521_720P_VIDEO_PANEL,
UNKNOWN_PANEL
};
```

3. Add the <vendor>_<resolution>_VIDEO_PANEL parameter to the panel_list_supp_panels struct.

```
static struct panel_list supp_panels[] = {
{"toshiba_720p_video", TOSHIBA_720P_VIDEO_PANEL},
{"nt35590_720p_cmd", NT35590_720P_CMD_PANEL},
{"nt35590_720p_video", NT35590_720P_VIDEO_PANEL},
{"hx8394a_720p_video", HX8394A_720P_VIDEO_PANEL},
+{"nt35521_720p_video", NT35521_720P_VIDEO_PANEL},
};
```

4. Add the <vendor>_<resolution>_VIDEO_PANEL case to the init_panel_data function.

```
static void init_panel_data(struct panel_struct *panelstruct,
          struct msm_panel_info *pinfo,
          struct mdss_dsi_phy_ctrl *phy_db)
{
   switch (panel_id) {
   +case NT35521_720P_VIDEO_PANEL:
   +   panelstruct->paneldata    = &nt35521_720p_video_panel_data;
   +   panelstruct->panelres     = &nt35521_720p_video_panel_res;
   +   panelstruct->color        = &nt35521_720p_video_color;
   +   panelstruct->videopanel   = &nt35521_720p_video_video_panel;
   +   panelstruct->commandpanel = &nt35521_720p_video_command_panel;
   +   panelstruct->state        = &nt35521_720p_video_state;
   +   panelstruct->laneconfig   = &nt35521_720p_video_lane_config;
   +   panelstruct->paneltiminginfo
                                 = &nt35521_720p_video_timing_info;
   +   panelstruct->panelresetseq
            = &nt35521_720p_video_panel_reset_seq;
   +   panelstruct->backlightinfo = &nt35521_720p_video_backlight;
   +   pinfo->mipi.panel_cmds
            = nt35521_720p_video_on_command;
   +   pinfo->mipi.num_of_panel_cmds
            = NT35521_720P_VIDEO_ON_COMMAND;
   +   memcpy(phy_db->timing,
         nt35521_720p_video_timings, TIMING_SIZE);
```

```
    break;
```

5. Select the panel ID according to `hw_id` in the `oem_panel_select` function.

```
enum target_subtype {
   HW_PLATFORM_SUBTYPE_SKUAA = 0,
   HW_PLATFORM_SUBTYPE_SKUF = 1,
   HW_PLATFORM_SUBTYPE_SKUAB = 2,
   HW_PLATFORM_SUBTYPE_SKUG = 3,
   +HW_PLATFORM_SUBTYPE_720P = 5,
};

switch (hw_id) {

   case HW_PLATFORM_MTP:
   case HW_PLATFORM_QRD:
      if (hw_subtype == HW_PLATFORM_SUBTYPE_720P)
      +   panel_id = NT35521_720P_VIDEO_PANEL;
      else
         panel_id = nt35590_panel_id;
      break;
   default:
      dprintf(CRITICAL, "Display not enabled for %d HW type\n"
                              , hw_id);
      return false;
```

2.7 Rebuild images, flash, and debug through adb

1. Rebuild the software.
2. Flash the `emmc_appsboot.mbn` and `boot.img` files onto the device.
3. Verify that the panel is lighted. If not, check the panel initialization commands, reset sequence, and measure the signal for DSI clock lane and data lane, etc.
4. If there is no DSI Clock output, check the DSI-related clocks using adb commands.
   a. adb root
   b. adb remount
   c. adb shell
   d. #mount –t debugfs none /sys/kernel/debug
   e. #cd /sys/kernel/debug/clk/dsi1_byte_clk
   f. #cat measure

EXHIBIT 1

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