ATK-DLMP157-MIPI 调试手册

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目录

前言

本文档主要是教大家如何，在 DLMP157 调试正点原子 5.5 寸的 720 屏。

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第一章 在 Uboot 点亮屏幕

1.1 设备树的修改

打开“arch/arm/dts/stm32mp157d-atk.dts”文件，

```
&dsi {
    #address-cells = <1>;
    #size-cells = <0>;
    status = "okay";

    ports {
        #address-cells = <1>;
        #size-cells = <0>;

        port@0 {
            reg = <0>;
            dsi_in: endpoint {
                remote-endpoint = <&ltdc_ep0_out>;
            };
        };

        port@1 {
            reg = <1>;
            dsi_out: endpoint {
                remote-endpoint = <&dsi_panel_in>;
            };
        };
    };

    panel_dsi: panel-dsi@0 {
        compatible = "himax,hx8394";
        reg = <0>;
        reset-gpios = <&gpioa 15 GPIO_ACTIVE_LOW>;
        backlight = <&panel_backlight>;
        power-supply = <&v3v3>;
        status = "okay";

        port {
            dsi_panel_in: endpoint {
                remote-endpoint = <&dsi_out>;
            };
        };
    };
```

```
};
```

Uboot 下的 dsi 节点是没有屏幕的相关的参数，因为已经写到驱动里面去了。dsi 节点不能和 panel_rgb 节点共存，所以如果使用了 MIPI 就需要屏蔽 panel_rgb 节点。

```
/*
    panel_rgb: panel-rgb {
        compatible = "simple-panel";
        backlight = <&panel_backlight>;
        status = "okay";

        port {
            panel_in_rgb: endpoint {
                remote-endpoint = <&ltdc_ep0_out>;
            };
        };
    };
*/
};
```

图 1.1.1 屏蔽 panel_rgb 节点

接着我们需要编写 ltdc 节点，此节点是控制 CPU 的显示数据，输出到 RGB 或者 MIPI 节点。所以我们需要修改 ltdc 节点指向 MIPI 节点。

```
&ltdc {
    status = "okay";
    pinctrl-names = "default", "sleep";
    pinctrl-0 = <&ltdc_pins_b>;
    pinctrl-1 = <&ltdc_pins_sleep_b>;

    port {
        #address-cells = <1>;
        #size-cells = <0>;

        ltdc_ep0_out: endpoint@0 {
            reg = <0>;
            remote-endpoint = <&dsi_in>;
        };
    };
};
```

上面的加粗的那一行，是指定到 dsi 节点里面。

1.2 驱动的编写。

1.2.1 驱动代码编写

开发板光盘 A-基础资料→01、程序源码→17、MIPI 屏幕→ himax-hx8394.c，拷贝文件到在 Uboot 的源码目录下“drivers/video/”下，也可以在此目录下创建 himax-hx8394.c 文件，输入以下示例代码：

```
#include <common.h>
#include <backlight.h>
#include <dm.h>
#include <mipi_dsi.h>
#include <panel.h>
#include <asm/gpio.h>
#include <power/regulator.h>

struct hx8394_panel_priv {
    struct udevice *reg;
    struct udevice *backlight;
    struct gpio_desc reset;
};

static const struct display_timing default_timing = {
    .pixelclock.typ     = 65000000,
    .hactive.typ        = 720,
    .hfront_porch.typ   = 48,
    .hback_porch.typ    = 52,
    .hsync_len.typ      = 8,
    .vactive.typ        = 1280,
    .vfront_porch.typ   = 16,
    .vback_porch.typ    = 15,
    .vsync_len.typ      = 5,
};

static void hx8394_dcs_write_buf(struct udevice *dev, const void *data,
                 size_t len)
{
    struct mipi_dsi_panel_plat *plat = dev_get_platdata(dev);
    struct mipi_dsi_device *device = plat->device;
    int err;

    err = mipi_dsi_dcs_write_buffer(device, data, len);
    if (err < 0)
        dev_err(dev, "MIPI DSI DCS write buffer failed: %d\n", err);
```

```
}


#define dcs_write_seq(ctx, seq...)            \
({                          \
    static const u8 d[] = { seq };            \
                            \
    hx8394_dcs_write_buf(ctx, d, ARRAY_SIZE(d));       \
})

static void hx8394_init_sequence(struct udevice *dev)
{
    dcs_write_seq(dev, 0XB9, 0xFF, 0x83, 0x94);
    dcs_write_seq(dev, 0X36, 0x1);
    dcs_write_seq(dev, 0XBA, 0X61, 0X03, 0X68, 0X6B, 0XB2, 0XC0);
    dcs_write_seq(dev, 0XB1, 0x48, 0x12, 0x72, 0x09, 0x32, 0x54,
                  0x71, 0x71, 0x57, 0x47);
    dcs_write_seq(dev, 0XB2, 0x00, 0x80, 0x64, 0x0C, 0x0D, 0x2F);
    dcs_write_seq(dev, 0XB4, 0x73, 0x74, 0x73, 0x74, 0x73, 0x74, 0x01,
                  0x0C, 0x86, 0x75, 0x00, 0x3F, 0x73, 0x74, 0x73,
0x74, 0x73, 0x74, 0x01, 0x0C, 0x86);
    dcs_write_seq(dev, 0XB6, 0x6E, 0x6E);
    dcs_write_seq(dev, 0XD3, 0x00, 0x00, 0x07, 0x07, 0x40, 0x07, 0x0C,
                  0x00, 0x08, 0x10, 0x08, 0x00, 0x08, 0x54, 0x15,
0x0A, 0x05, 0x0A, 0x02, 0x15, 0x06,
                  0x05, 0x06, 0x47, 0x44, 0x0A, 0x0A, 0x4B, 0x10,
0x07, 0x07, 0x0C, 0x40);
    dcs_write_seq(dev, 0XD5, 0x1C, 0x1C, 0x1D, 0x1D, 0x00, 0x01, 0x02,
                  0x03, 0x04, 0x05, 0x06, 0x07, 0x08, 0x09, 0x0A,
0x0B, 0x24, 0x25, 0x18, 0x18, 0x26,
                  0x27, 0x18, 0x18, 0x18, 0x18, 0x18, 0x18, 0x18,
0x18, 0x18, 0x18, 0x18, 0x18, 0x18,
                  0x18, 0x18, 0x18, 0x20, 0x21, 0x18, 0x18, 0x18,
0x18);
    dcs_write_seq(dev, 0XD6, 0x1C, 0x1C, 0x1D, 0x1D, 0x07, 0x06, 0x05,
                  0x04, 0x03, 0x02, 0x01, 0x00, 0x0B, 0x0A, 0x09,
0x08, 0x21, 0x20, 0x18, 0x18, 0x27,
                  0x26, 0x18, 0x18, 0x18, 0x18, 0x18, 0x18, 0x18,
0x18, 0x18, 0x18, 0x18, 0x18, 0x18,
                  0x18, 0x18, 0x18, 0x25, 0x24, 0x18, 0x18, 0x18,
0x18);
    dcs_write_seq(dev, 0XE0, 0x00, 0x0A, 0x15, 0x1B, 0x1E, 0x21, 0x24,
```

```
                    0x22, 0x47, 0x56, 0x65, 0x66, 0x6E, 0x82, 0x88,
0x8B, 0x9A, 0x9D, 0x98, 0xA8, 0xB9,
                    0x5D, 0x5C, 0x61, 0x66, 0x6A, 0x6F, 0x7F, 0x7F,
0x00, 0x0A, 0x15, 0x1B, 0x1E, 0x21,
                    0x24, 0x22, 0x47, 0x56, 0x65, 0x65, 0x6E, 0x81,
0x87, 0x8B, 0x98, 0x9D, 0x99, 0xA8,
                    0xBA, 0x5D, 0x5D, 0x62, 0x67, 0x6B, 0x72, 0x7F,
0x7F);
    dcs_write_seq(dev, 0xC0, 0x1F, 0x31);
    dcs_write_seq(dev, 0XCC, 0x03);
    dcs_write_seq(dev, 0xD4, 0x02);
    dcs_write_seq(dev, 0XBD, 0x02);
    dcs_write_seq(dev, 0xD8, 0xFF, 0xFF, 0xFF, 0xFF, 0xFF, 0xFF, 0xFF,
0xFF, 0xFF, 0xFF, 0xFF, 0xFF);
    dcs_write_seq(dev, 0XBD, 0x00);
    dcs_write_seq(dev, 0XBD, 0x01);
    dcs_write_seq(dev, 0XB1, 0x00);
    dcs_write_seq(dev, 0XBD, 0x00);
    dcs_write_seq(dev, 0xBF, 0x40, 0x81, 0x50, 0x00, 0x1A, 0xFC, 0x01);
    dcs_write_seq(dev, 0xC6, 0xED);
}

static int hx8394_panel_enable_backlight(struct udevice *dev)
{
    struct mipi_dsi_panel_plat *plat = dev_get_platdata(dev);
    struct mipi_dsi_device *device = plat->device;
    struct hx8394_panel_priv *priv = dev_get_priv(dev);
    int ret;

    ret = mipi_dsi_attach(device);
    if (ret < 0)
        return ret;

    hx8394_init_sequence(dev);
    mdelay(120);
    ret = mipi_dsi_dcs_exit_sleep_mode(device);
    if (ret)
        return ret;

    ret = mipi_dsi_dcs_set_display_on(device);
    if (ret)
        return ret;
```

```
    mdelay(120);

    ret = backlight_enable(priv->backlight);
    if (ret)
        return ret;

    return 0;
}

static int hx8394_panel_get_display_timing(struct udevice *dev,
                    struct display_timing *timings)
{
    memcpy(timings, &default_timing, sizeof(*timings));

    return 0;
}

static int hx8394_panel_ofdata_to_platdata(struct udevice *dev)
{
    struct hx8394_panel_priv *priv = dev_get_priv(dev);
    int ret;

    if (IS_ENABLED(CONFIG_DM_REGULATOR)) {
        ret =  device_get_supply_regulator(dev, "power-supply",
                        &priv->reg);
        if (ret && ret != -ENOENT) {
            dev_err(dev, "Warning: cannot get power supply\n");
            return ret;
        }
    }

    ret = gpio_request_by_name(dev, "reset-gpios", 0, &priv->reset,
                GPIOD_IS_OUT);
    if (ret) {
        dev_err(dev, "Warning: cannot get reset GPIO\n");
        if (ret != -ENOENT)
            return ret;
    }

    ret = uclass_get_device_by_phandle(UCLASS_PANEL_BACKLIGHT, dev,
                    "backlight", &priv->backlight);
    if (ret) {
        dev_err(dev, "Cannot get backlight: ret=%d\n", ret);
```

```
        return ret;
    }

    return 0;
}

static int hx8394_panel_probe(struct udevice *dev)
{
    struct hx8394_panel_priv *priv = dev_get_priv(dev);
    struct mipi_dsi_panel_plat *plat = dev_get_platdata(dev);
    int ret;

    if (IS_ENABLED(CONFIG_DM_REGULATOR) && priv->reg) {
        ret = regulator_set_enable(priv->reg, true);
        if (ret)
            return ret;
    }

    /* fill characteristics of DSI data link */
    plat->lanes = 2;
    plat->format = MIPI_DSI_FMT_RGB888;
    plat->mode_flags = MIPI_DSI_MODE_VIDEO |
              MIPI_DSI_MODE_VIDEO_BURST |
              MIPI_DSI_MODE_LPM;

    return 0;
}

static const struct panel_ops hx8394_panel_ops = {
    .enable_backlight = hx8394_panel_enable_backlight,
    .get_display_timing = hx8394_panel_get_display_timing,
};

static const struct udevice_id hx8394_panel_ids[] = {
    { .compatible = "himax,hx8394" },
    { }
};

U_BOOT_DRIVER(hx8394_panel) = {
    .name           = "hx8394_panel",
    .id         = UCLASS_PANEL,
    .of_match       = hx8394_panel_ids,
    .ops            = &hx8394_panel_ops,
```

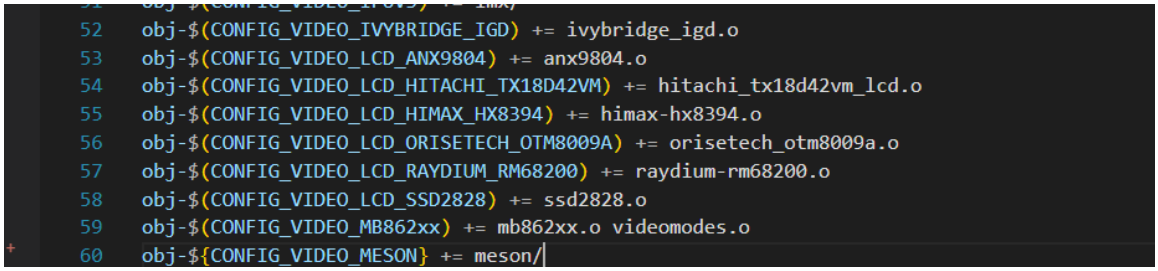
```
    .ofdata_to_platdata   = hx8394_panel_ofdata_to_platdata,
    .probe            = hx8394_panel_probe,
    .platdata_auto_alloc_size = sizeof(struct mipi_dsi_panel_plat),
    .priv_auto_alloc_size   = sizeof(struct hx8394_panel_priv),
};
```

1.2.2 把代码添加到 uboot 里面

在 uboot 的源码目录下打开“drivers/video/Makefile”在 54 行下，添加以下代码：

```
obj-$(CONFIG_VIDEO_LCD_HIMAX_HX8394) += himax-hx8394.o
```

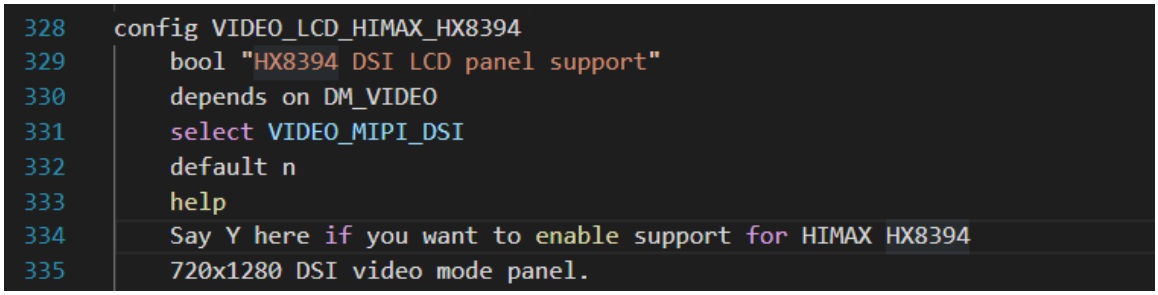
添加如下图所示：



接着去修改 Kconfig，打开“drivers/video/Kconfig”，在第 328 行，添加以下示例代码：

```
config VIDEO_LCD_HIMAX_HX8394
    bool "HX8394 DSI LCD panel support"
    depends on DM_VIDEO
    select VIDEO_MIPI_DSI
    default n
    help
    Say Y here if you want to enable support for HIMAX HX8394
    720x1280 DSI video mode panel.
```

添加结果如下图所示：



1.3 使能 HX8394 驱动

我们首先生成“.config”文件，运行命令如下所示：

```
make stm32mp157d_atk_defconfig
```

接着我们进入图形配置界面，按照以下路径配置 HX8394 把这个驱动编译进 uboot 里。

```
Device Drivers
    → Graphics support
        [*] HX8394 DSI LCD panel support
```

配置如下图所示：

```
[ ]   Support rotated displays
[ ]   Support a console that uses TrueType fonts
[ ] Display console as white on a black background
[ ] Skip framebuffer clear
    TrueType Fonts  ----
[ ] Use 'vidconsole' when 'lcd' is seen in stdout
[ ] Enable VESA video driver support
[ ] ANX9804 bridge chip
[*] HX8394 DSI LCD panel support
[*] OTM8009A DSI LCD panel support
[*] RM68200 DSI LCD panel support
[ ] SSD2828 bridge chip
[ ] Enable Amlogic Meson video support
[ ] Armada XP LCD controller
[ ] Enable EDID library
[ ] Enable Display support
[ ] Enable ATMEL video support using HLCDC
[ ] Enable Freescale Display Control Unit
[ ] Enable Rockchip Video Support  ----
[ ] Enable Arm Mali Display Processor support
```

配置完成后就我们就可以进行编译源码，这个时候我们可以看出 hx8394 编译进 uboot。

1.4 烧录测试

替换 u-boot.stm32 后，进入 uboot 命令终端，运行以下命令进行测试：

```
ext4load mmc 1:2 c4300000    alientek_480x272.bmp
bmp display c4300000
```

这里我的是出厂系统，所以在 emmc 里面第二个分区里面有 bmp 图片，选择 alientek_480x272.bmp 进行测试。

第二章 在 Linux 点亮屏幕

2.1 设备树的修改

dsi 节点和 uboot 节点是一样的，所以拷贝 1.1 小节的设备树。接着我们就可以修改 ltdc 节点。修改代码如下示例代码所示：

```
&ltdc {
    port {
        #address-cells = <1>;
        #size-cells = <0>;

        ltdc_ep1_out: endpoint@1 {
            reg = <1>;
            remote-endpoint = <&dsi_in>;
        };
```

```
    };
};
```

2.2 驱动的编写

2.2.1 驱动代码编译

发板光盘 A-基础资料→01、程序源码→17、MIPI 屏幕→ himax-hx8394.c，拷贝文件到 kernel 的源码目录下“drivers/gpu/drm/panel/”，也可以在此路径创建 panel-himax-hx8394.c 文件，panel-himax-hx8394.c 把以下代码拷贝到此文件里：

```
// SPDX-License-Identifier: GPL-2.0
/*
 * Authors: Wencong Liang <liangwc21@126.com>
 *
 */
#include <linux/backlight.h>
#include <linux/delay.h>
#include <linux/gpio/consumer.h>
#include <linux/module.h>
#include <linux/regulator/consumer.h>
#include <video/mipi_display.h>
#include <drm/drm_mipi_dsi.h>
#include <drm/drm_modes.h>
#include <drm/drm_panel.h>
#include <drm/drm_print.h>

struct hx8394 {
    struct device *dev;
    struct drm_panel panel;
    struct gpio_desc *reset_gpio;
    struct regulator *supply;
    struct backlight_device *backlight;
    bool prepared;
    bool enabled;
};

static const struct drm_display_mode default_mode = {
    .clock = 65000,
    .hdisplay = 720,
    .hsync_start =  720+ 52,
    .hsync_end = 720 + 52 + 8 ,
    .htotal = 720 + 52 + 8 +48 ,
    .vdisplay = 1280,
    .vsync_start = 1280 + 15,
```

```
    .vsync_end = 1280 + 15 + 6,
    .vtotal = 1280 + 15 + 6 + 16,
    .vrefresh = 60,
    .flags = DRM_MODE_FLAG_NHSYNC | DRM_MODE_FLAG_NVSYNC,
    .width_mm = 74,
    .height_mm = 150,
};


static inline struct hx8394 *panel_to_hx8394(struct drm_panel *panel)
{
    return container_of(panel, struct hx8394, panel);
}


static void hx8394_dcs_write_buf(struct hx8394 *ctx, const void *data,
                 size_t len)
{
    struct mipi_dsi_device *dsi = to_mipi_dsi_device(ctx->dev);
    int err;

    err = mipi_dsi_dcs_write_buffer(dsi, data, len);
    if (err < 0)
        DRM_ERROR_RATELIMITED("MIPI DSI DCS write buffer failed: %d\n",
                      err);
}

#define dcs_write_seq(ctx, seq...)            \
({                            \
    static const u8 d[] = { seq };            \
                            \
    hx8394_dcs_write_buf(ctx, d, ARRAY_SIZE(d));    \
})

static int hx8394_init_sequence(struct hx8394 *ctx)
{
    dcs_write_seq(ctx, 0XB9, 0xFF, 0x83, 0x94);
    dcs_write_seq(ctx, 0X36, 0x1);
    dcs_write_seq(ctx, 0XBA, 0X61, 0X03, 0X68, 0X6B, 0XB2, 0XC0);
    dcs_write_seq(ctx, 0XB1, 0x48, 0x12, 0x72, 0x09, 0x32, 0x54,
                  0x71, 0x71, 0x57, 0x47);
    dcs_write_seq(ctx, 0XB2, 0x00, 0x80, 0x64, 0x0C, 0x0D, 0x2F);
    dcs_write_seq(ctx, 0XB4, 0x73, 0x74, 0x73, 0x74, 0x73, 0x74, 0x01,
```

```
                    0x0C, 0x86, 0x75, 0x00, 0x3F, 0x73, 0x74, 0x73,
0x74, 0x73, 0x74, 0x01, 0x0C, 0x86);
    dcs_write_seq(ctx, 0XB6, 0x6E, 0x6E);
    dcs_write_seq(ctx, 0XD3, 0x00, 0x00, 0x07, 0x07, 0x40, 0x07, 0x0C,
                    0x00, 0x08, 0x10, 0x08, 0x00, 0x08, 0x54, 0x15,
0x0A, 0x05, 0x0A, 0x02, 0x15, 0x06,
                    0x05, 0x06, 0x47, 0x44, 0x0A, 0x0A, 0x4B, 0x10,
0x07, 0x07, 0x0C, 0x40);
    dcs_write_seq(ctx, 0XD5, 0x1C, 0x1C, 0x1D, 0x1D, 0x00, 0x01, 0x02,
                    0x03, 0x04, 0x05, 0x06, 0x07, 0x08, 0x09, 0x0A,
0x0B, 0x24, 0x25, 0x18, 0x18, 0x26,
                    0x27, 0x18, 0x18, 0x18, 0x18, 0x18, 0x18, 0x18,
0x18, 0x18, 0x18, 0x18, 0x18, 0x18,
                    0x18, 0x18, 0x18, 0x20, 0x21, 0x18, 0x18, 0x18,
0x18);
    dcs_write_seq(ctx, 0XD6, 0x1C, 0x1C, 0x1D, 0x1D, 0x07, 0x06, 0x05,
                    0x04, 0x03, 0x02, 0x01, 0x00, 0x0B, 0x0A, 0x09,
0x08, 0x21, 0x20, 0x18, 0x18, 0x27,
                    0x26, 0x18, 0x18, 0x18, 0x18, 0x18, 0x18, 0x18,
0x18, 0x18, 0x18, 0x18, 0x18, 0x18,
                    0x18, 0x18, 0x18, 0x25, 0x24, 0x18, 0x18, 0x18,
0x18);
    dcs_write_seq(ctx, 0XE0, 0x00, 0x0A, 0x15, 0x1B, 0x1E, 0x21, 0x24,
                    0x22, 0x47, 0x56, 0x65, 0x66, 0x6E, 0x82, 0x88,
0x8B, 0x9A, 0x9D, 0x98, 0xA8, 0xB9,
                    0x5D, 0x5C, 0x61, 0x66, 0x6A, 0x6F, 0x7F, 0x7F,
0x00, 0x0A, 0x15, 0x1B, 0x1E, 0x21,
                    0x24, 0x22, 0x47, 0x56, 0x65, 0x65, 0x6E, 0x81,
0x87, 0x8B, 0x98, 0x9D, 0x99, 0xA8,
                    0xBA, 0x5D, 0x5D, 0x62, 0x67, 0x6B, 0x72, 0x7F,
0x7F);
    dcs_write_seq(ctx, 0xC0, 0x1F, 0x31);
    dcs_write_seq(ctx, 0XCC, 0x03);
    dcs_write_seq(ctx, 0xD4, 0x02);
    dcs_write_seq(ctx, 0XBD, 0x02);
    dcs_write_seq(ctx, 0xD8, 0xFF, 0xFF, 0xFF, 0xFF, 0xFF, 0xFF, 0xFF,
0xFF, 0xFF, 0xFF, 0xFF, 0xFF);
    dcs_write_seq(ctx, 0XBD, 0x00);
    dcs_write_seq(ctx, 0XBD, 0x01);
    dcs_write_seq(ctx, 0XB1, 0x00);
    dcs_write_seq(ctx, 0XBD, 0x00);
    dcs_write_seq(ctx, 0xBF, 0x40, 0x81, 0x50, 0x00, 0x1A, 0xFC, 0x01);
    dcs_write_seq(ctx, 0xC6, 0xED);
```

```
    return 0;
}


static int hx8394_disable(struct drm_panel *panel)
{
    struct hx8394 *ctx = panel_to_hx8394(panel);

    if (!ctx->enabled)
        return 0;

    backlight_disable(ctx->backlight);

    ctx->enabled = false;

    return 0;
}

static int hx8394_unprepare(struct drm_panel *panel)
{
    struct hx8394 *ctx = panel_to_hx8394(panel);
    struct mipi_dsi_device *dsi = to_mipi_dsi_device(ctx->dev);
    int ret;

    if (!ctx->prepared)
        return 0;

    ret = mipi_dsi_dcs_set_display_off(dsi);
    if (ret)
        DRM_WARN("failed to set display off: %d\n", ret);

    ret = mipi_dsi_dcs_enter_sleep_mode(dsi);
    if (ret)
        DRM_WARN("failed to enter sleep mode: %d\n", ret);

    msleep(120);

    regulator_disable(ctx->supply);

    ctx->prepared = false;

    return 0;
```

```
}

static int hx8394_enable(struct drm_panel *panel)
{
    struct hx8394 *ctx = panel_to_hx8394(panel);

  if (ctx->enabled)
        return 0;

    ctx->prepared = true;

    return 0;
}

static int hx8394_prepare(struct drm_panel *panel)
{
    struct hx8394 *ctx = panel_to_hx8394(panel);
    struct mipi_dsi_device *dsi = to_mipi_dsi_device(ctx->dev);
    int ret;

    if (ctx->enabled)
        return 0;

    ret = regulator_enable(ctx->supply);
    if (ret < 0) {
        DRM_ERROR("failed to enable supply: %d\n", ret);
        return ret;
    }

    hx8394_init_sequence(ctx);

    msleep(120);

    ret = mipi_dsi_dcs_exit_sleep_mode(dsi);
    if (ret)
        return ret;

    ret = mipi_dsi_dcs_set_display_on(dsi);
    if (ret)
        return ret;

    msleep(120);
```

```
    backlight_enable(ctx->backlight);

    ctx->enabled = true;

    return 0;
}

static int hx8394_get_modes(struct drm_panel *panel)
{
    struct drm_display_mode *mode;

    mode = drm_mode_duplicate(panel->drm, &default_mode);
    if (!mode) {
        DRM_ERROR("failed to add mode %ux%ux@%u\n",
             default_mode.hdisplay, default_mode.vdisplay,
             default_mode.vrefresh);
        return -ENOMEM;
    }
    drm_mode_set_name(mode);

    mode->type = DRM_MODE_TYPE_DRIVER | DRM_MODE_TYPE_PREFERRED;
    drm_mode_probed_add(panel->connector, mode);

    panel->connector->display_info.width_mm = mode->width_mm;
    panel->connector->display_info.height_mm = mode->height_mm;

    return 1;
}

static const struct drm_panel_funcs hx8394_drm_funcs = {
    .disable = hx8394_disable,
    .unprepare = hx8394_unprepare,
    .prepare = hx8394_prepare,
    .enable = hx8394_enable,
    .get_modes = hx8394_get_modes,
};


static int hx8394_probe(struct mipi_dsi_device *dsi)
{
    struct device *dev = &dsi->dev;
    struct hx8394 *ctx;
    int ret;
```

```
    ctx = devm_kzalloc(dev, sizeof(*ctx), GFP_KERNEL);
    if (!ctx)
        return -ENOMEM;

    ctx->reset_gpio = devm_gpiod_get_optional(dev, "reset",
GPIOD_OUT_LOW);
    if (IS_ERR(ctx->reset_gpio)) {
        ret = PTR_ERR(ctx->reset_gpio);
        dev_err(dev, "cannot get reset GPIO: %d\n", ret);
        return ret;
    }

    ctx->supply = devm_regulator_get(dev, "power");
    if (IS_ERR(ctx->supply)) {
        ret = PTR_ERR(ctx->supply);
        if (ret != -EPROBE_DEFER)
            dev_err(dev, "cannot get regulator: %d\n", ret);
        return ret;
    }

    ctx->backlight = devm_of_find_backlight(dev);
    if (IS_ERR(ctx->backlight))
        return PTR_ERR(ctx->backlight);

    mipi_dsi_set_drvdata(dsi, ctx);

    ctx->dev = dev;

    dsi->lanes = 2;
    dsi->format = MIPI_DSI_FMT_RGB888;
     dsi->mode_flags = MIPI_DSI_MODE_VIDEO | MIPI_DSI_MODE_VIDEO_BURST |
            MIPI_DSI_MODE_LPM | MIPI_DSI_CLOCK_NON_CONTINUOUS;

    drm_panel_init(&ctx->panel);
    ctx->panel.dev = dev;
    ctx->panel.funcs = &hx8394_drm_funcs;

    drm_panel_add(&ctx->panel);

    ret = mipi_dsi_attach(dsi);
    if (ret < 0) {
        dev_err(dev, "mipi_dsi_attach() failed: %d\n", ret);
```

```
        drm_panel_remove(&ctx->panel);
        return ret;
    }

    return 0;
}

static int hx8394_remove(struct mipi_dsi_device *dsi)
{
    struct hx8394 *ctx = mipi_dsi_get_drvdata(dsi);

    mipi_dsi_detach(dsi);
    drm_panel_remove(&ctx->panel);

    return 0;
}

static const struct of_device_id himax_hx8394_of_match[] = {
    { .compatible = "himax,hx8394" },
    { }
};
MODULE_DEVICE_TABLE(of, himax_hx8394_of_match);

static struct mipi_dsi_driver himax_hx8394_driver = {
    .probe = hx8394_probe,
    .remove = hx8394_remove,
    .driver = {
        .name = "panel-himax-hx8394",
        .of_match_table = himax_hx8394_of_match,
    },
};
module_mipi_dsi_driver(himax_hx8394_driver);

MODULE_AUTHOR("Wencong Liang <liangwc21@126.com>");
MODULE_DESCRIPTION("DRM Driver for Himax hx8394 MIPI DSI panel");
MODULE_LICENSE("GPL v2");
```

2.2.2 把代码添加到 kernel 里面

在 kernel 的源码目录下打开“drivers/gpu/drm/panel/Makefile”在最后添加以下代码：

```
obj-$(CONFIG_DRM_PANEL_HIMAX_HX8394) += panel-himax-hx8394.o
```

添加如下图所示：

```
37  obj-$(CONFIG_DRM_PANEL_TPO_TD028TTEC1) += panel-tpo-td028ttec1.o
38  obj-$(CONFIG_DRM_PANEL_TPO_TD043MTEA1) += panel-tpo-td043mtea1.o
39  obj-$(CONFIG_DRM_PANEL_TPO_TPG110) += panel-tpo-tpg110.o
40  obj-$(CONFIG_DRM_PANEL_TRULY_NT35597_WQXGA) += panel-truly-nt35597.o
41  obj-$(CONFIG_DRM_PANEL_HIMAX_HX8394) += panel-himax-hx8394.o
42
```

接着去修改 Kconfig，打开“drivers/gpu/drm/panel/Kconfig”，在第 328 行，添加以下示例代码：

```
config DRM_PANEL_HIMAX_HX8394
    tristate "HiMax Hx8394 panel driver"
    depends on OF
    depends on DRM_MIPI_DSI
    depends on BACKLIGHT_CLASS_DEVICE
    help
      Say Y here if you want to enable support for the HIMAX
      HX8394 controller for 720X1280 LCD panels with MIPI
          system interfaces.
```

修改结果如下图所示：

```
42  config DRM_PANEL_HIMAX_HX8394
43      tristate "HiMax Hx8394 panel driver"
44      depends on OF
45      depends on DRM_MIPI_DSI
46      depends on BACKLIGHT_CLASS_DEVICE
47      help
48        Say Y here if you want to enable support for the HIMAX
49        HX8394 controller for 720X1280 LCD panels with MIPI
50        system interfaces.
```

2.3 使能 HX8394 驱动

我们首先生成“.config”文件，运行命令如下所示：

```
make stm32mp1_atk_defconfig
```

接着我们进入图形配置界面，按照以下路径配置 HX8394 把这个驱动编译进 kernel。

```
Device Drivers
    →Graphics support
        → Display Panels
            → <*> HiMax Hx8394 panel driver
```

配置结果如下图所示：

```
< > ARM Versatile panel driver
< > Generic LVDS panel driver
<*> support for simple panels
<*> HiMax Hx8394 panel driver
< > Feiyang FY07024DI26A30-D MIPI-DSI LCD panel
< > Ilitek ILI9322 320x240 QVGA panels
< > Ilitek ILI9881C-based panels
< > Innolux P079ZCA panel
< > JDI LT070ME05000 WUXGA DSI panel
< > Kingdisplay kd097d04 panel
<M> Samsung LD9040 RGB/SPI panel
< > LG LB035Q024573 RGB panel
< > LG4573 RGB/SPI panel
< > NEC NL8048HL11 RGB panel
< > Novatek NT39016 RGB/SPI panel
< > Olimex LCD-OLinuXino panel
<*> Orise Technology otm8009a 480x800 dsi 2dl panel
< > OSD OSD101T2587-53TS DSI 1920x1200 video mode panel
< > Panasonic VVX10F034N00 1920x1200 video mode panel
< > Raspberry Pi 7-inch touchscreen panel
```

配置完成后就可以编译测试，替换 uImage 和设备树进行测试。