INTERNAL USE

MT8183 O1 LCM Driver Customization

Outlines

- O1 Display Driver Location
- MIPI DSI LCM Configuration
- MIPI DSI driver case study
- LVDS driver case study
- RGB driver case study

O1 kernel-4.4 Display Driver Location

Linux framebuffer	<kernel-4.4>/drivers/video
	fbmem.c
	<kernel-4.4>/include/linux/
	fb.h
MTK framebuffer	<kernel-4.4>/drivers/misc/mediatek/video/common
	mtkfb.h mtkfb_vsync.h
Video	<kernel-4.4>/drivers/misc/mediatek/video/mt8183/videox
	disp_lcm.c disp_lcm.h primary_display.c primary_display.h disp_drv_ddp.c disp_drv_ddp.h mtk_disp_mgr.c mtk_disp_mgr.h debug.c debug.h disp_utlis.c disp_utlis.h
Display system	<kernel-4.4>/drivers/misc/mediatek/video/mt8183/dispsys
	ddp_drv.c ddp_path.c ddp_aal.c ddp_wdma.c ddp_rdma.c ddp_bls.c ddp_ovl.c ddp_drv.h ddp_path.h ddp_aal.h ddp_wdma.h ddp_rdma.h ddp_reg.h ddp_dsi.c ddp_dpi.c
LCM driver	<kernel-4.4>/drivers/misc/mediatek/lcm
	lcm_drv.c

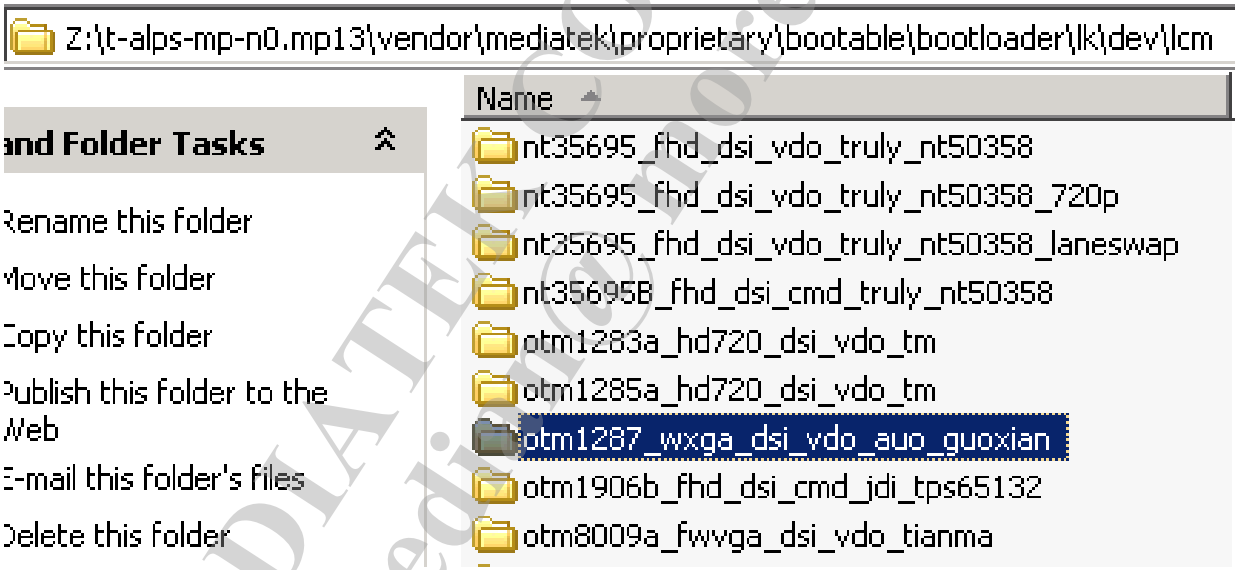
O1 LK Display Driver Location

- LCM driver
  - Vendor/mediatek/proprietary/bootable/bootloader/lk/dev/lcm
- Videox&display
  - Vendor/mediatek/proprietary/bootable/bootloader/lk/platform/mt8183

MIPI DSI LCM Configuration

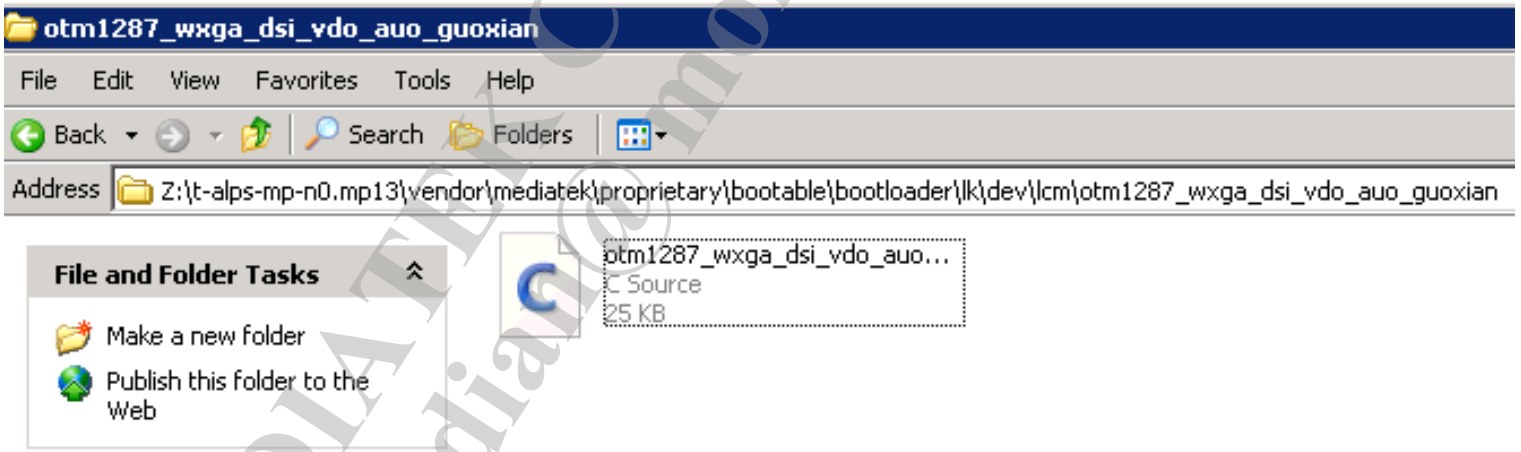
LK LCM Configuration (1/x)

- Step 1: Add your <lcm driver>
  - Add your <lcm driver> into the following path:
    - Alps\vendor\mediatek\proprietary\bootable\bootloader\lk\dev\lcm\
  - Take <otm1287_wxga_dsi_vdo_auo_guoxian> for example:



LK LCM Configuration (2/x)

- Step 2: Add LCM Makefile
  - No need add LCM Makefile into the following path:
    - Alps\vendor\mediatek\proprietary\bootable\bootloader\lk\dev\lcm\<lcm driver>
  - Take < otm1287_wxga_dsi_vdo_auo_guoxian > for example:



LK LCM Configuration (3/x)

- Step 3: Add your <lcm config> in <project> makefile
  - Add your <lcm confing> in <project>.mk
    alps\vendor\mediatek\propreitary\bootable\bootloader\lk\project\<project>.mk
  - Take < otm1287_wxga_dsi_vdo_auo_guoxian > for example:

```
10  DEFINES += MTK_NEW_COMBO_EMMC_SUPPORT
11  MTK_KERNEL_POWER_OFF_CHARGING = yes
12  #DEFINES += SWCHR_POWER_PATH
13  #DEFINES += MTK_BQ24261_SUPPORT
14  MTK_LCM_PHYSICAL_ROTATION=0
15  CUSTOM_LK_LCM="otm1287_wxga_dsi_vdo_auo_guoxian"
16  #nt35595_fhd_dsi_cmd_truly_nt50358 = yes
17
18  #FASTBOOT_USE_G_ORIGINAL_PROTOCOL = yes
19  MTK_SECURITY_SW_SUPPORT = yes
20  MTK_VERIFIED_BOOT_SUPPORT = yes
21  MTK_SEC_FASTBOOT_UNLOCK_SUPPORT = yes
22
23  BOOT_LOGO=wxga
```

Config lcm rotation

If the case is single LCM, mark previous <lcm configuration> and add yours here

If the case is multiple LCMs, add the <lcm configuration> after previous one

LK LCM Configuration (4/x)

- Step 4: Add your <lcm main structure> into lcm list
  - Add your <lcm main structure> into lcm list in alps\vendor\mediatek\propreitary\bootable\bootloader\lk\dev\lcm \mt65xx_lcm_list.c
  - Take < otm1287_wxga_dsi_vdo_auo_guoxian > for example:

```
307   extern LCM_DRIVER r61322_fhd_dsi_vdo_sharp_lfr_lcm_drv;
308   extern LCM_DRIVER s6e3ha3_wqhd_2k_cmd_laneswap_drv;
309   extern LCM_DRIVER otm1287_wxga_dsi_vdo_auo_guoxian_lcm_drv;
310   extern LCM_DRIVER jd9365_wxga_dsi_vdo_hsd_pingbo_lcm_drv;
```

Add your <lcm main structure> into lcm list

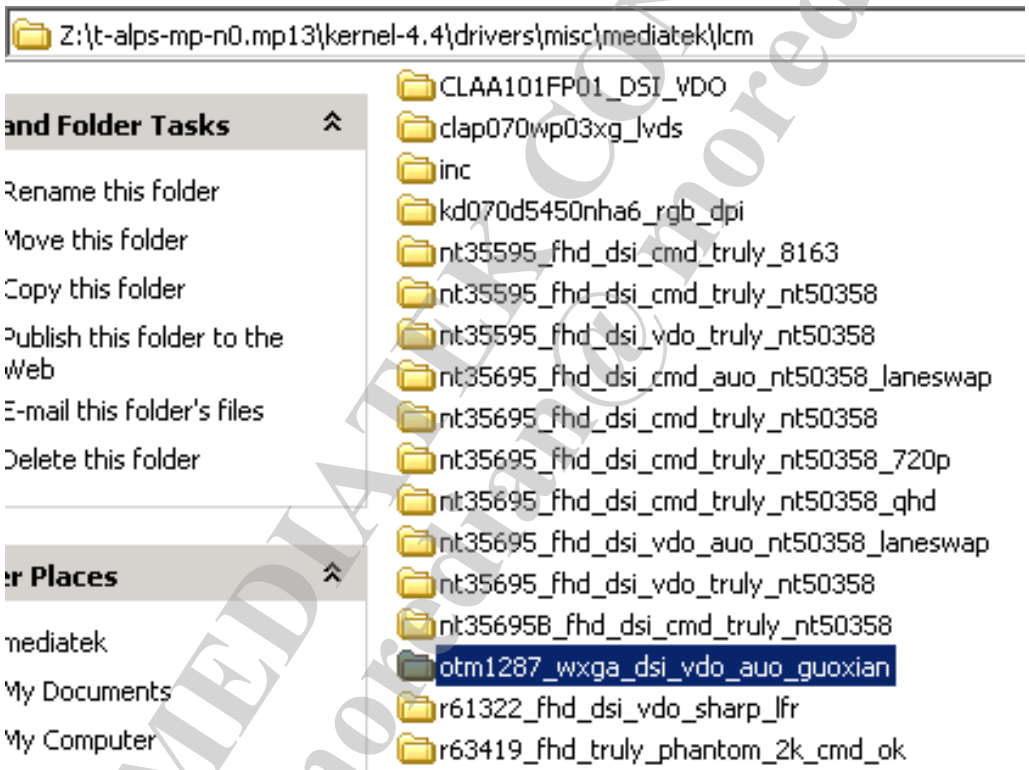
```
1320
1321  #if defined(OTM1287_WXGA_DSI_VDO_AUO_GUOXIAN)
1322      &otm1287_wxga_dsi_vdo_auo_guoxian_lcm_drv,
1323  #endif
```

LK LCM Configuration (5/x)

- Step 5: Switch logo if LCM resolution is different.
  - Modify define marco of BOOT_LOGO in
  - alps\vendor\mediatek\propreitary\bootable\bootloader\lk\project\<project>.mk
  - Take < otm1287_wxga_dsi_vdo_auo_guoxian > for example:

Kernel-4.4 LCM Configuration (1/x)

- Step 1: Add your <lcm driver>
  - Add your <lcm driver> into the following path:
    - alps\kernel-4.4\drivers\misc\mediatek\lcm\
  - Take < otm1287_wxga_dsi_vdo_auo_guoxian > for example:



Add your <lcm driver>

Kernel-4.4 LCM Configuration (2/x)

- Step 2: Add LCM Makefile
  - Add LCM Makefile into the following path:
    - alps\kernel-4.4\drivers\misc\mediatek\lcm\<lcm driver>
  - Take < otm1287_wxga_dsi_vdo_auo_guoxian > for example:
  - Obj-y += otm1287_wxga_dsi_vdo_auo_guoxian .o

Kernel-4.4 LCM Configuration (3/x)

- Step 3: Add your <lcm main structure> into lcm list
  - Add your <lcm main structure> into lcm list in
  - Take < otm1287_wxga_dsi_vdo_auo_guoxian > for example:
  - alps\kernel-4.4\drivers\misc\mediatek\lcm\mt65xx_lcm_list.h

```
262  extern LCM_DRIVER s6e3ha3_wqhd_2k_cmd_laneswap_drv;
263  extern LCM_DRIVER otm1287_wxga_dsi_vdo_auo_guoxian_lcm_drv;
264  extern LCM_DRIVER jd9365_wxga_dsi_vdo_hsd_pingbo_lcm_drv;
```

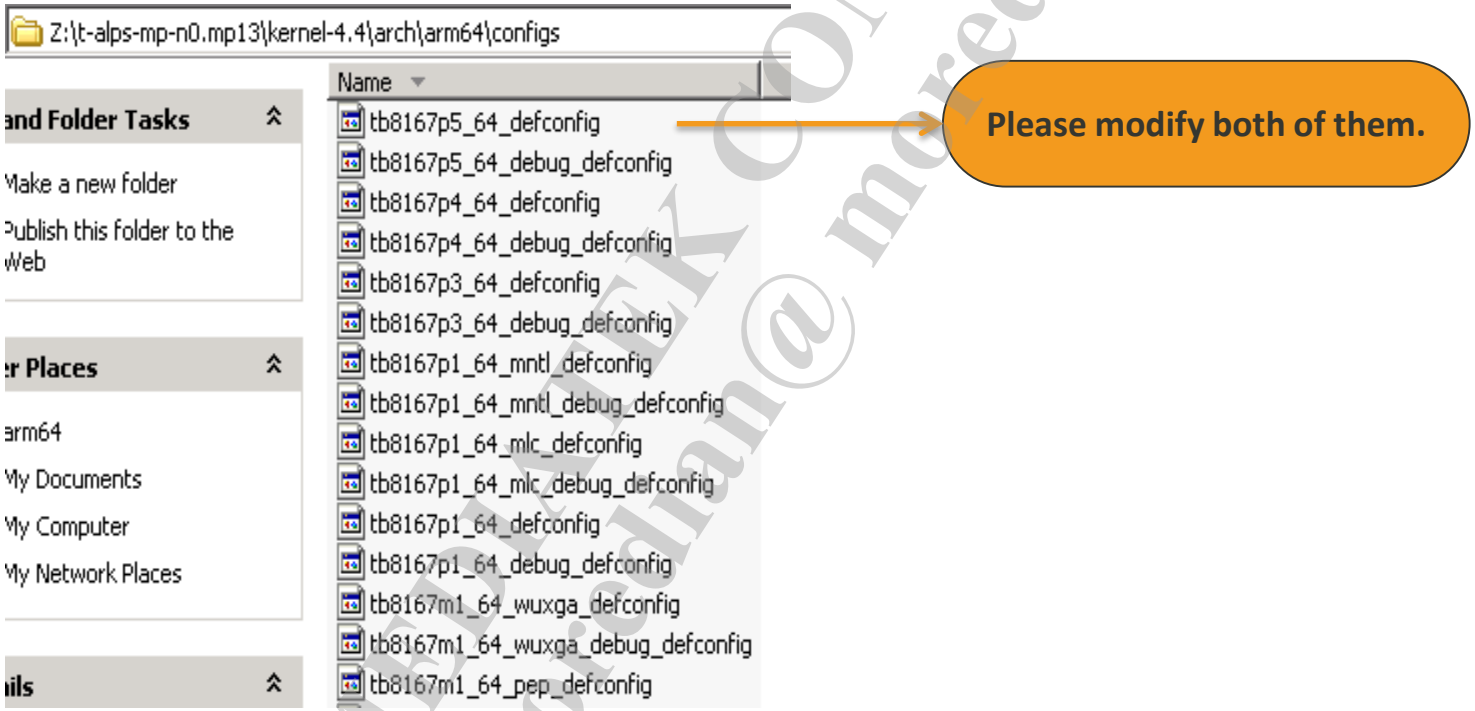
  - alps\kernel-4.4\drivers\misc\mediatek\lcm\mt65xx_lcm_list.c

Add your <lcm main structure> into lcm list

```
1006  #if defined(OTM1287_WXGA_DSI_VDO_AUO_GUOXIAN)
1007      &otm1287_wxga_dsi_vdo_auo_guoxian_lcm_drv,
1008  #endif
1009
```

Kernel-4.4 LCM Configuration (4/x)

- Add your <lcm> into kernel config
  - alps\kernel-4.4\arch\arm64\configs\<project>_debug_defconfig && <project>_defconfig
  - Take < otm1287_wxga_dsi_vdo_auo_guoxian > for example:



tb8167p5_64_defconfig

```
174  CONFIG_MTK_PSCI=y
175  CONFIG_MTK_SHARED_SDCARD=y
176  CONFIG_MTK_GPT_SCHEME_SUPPORT=y
177  CONFIG_MTK_FREQ_HOPPING=y
178  # CONFIG_MTK_PMIC_WRAP_HAL is not set
179  CONFIG_CUSTOM_KERNEL_IMGSENSOR="ov5675_mipi_raw sp2509_mipi_raw"
180  CONFIG_MTK_SEC_VIDEO_PATH_SUPPORT=y
181  CONFIG_MTK_DRM_KEY_MNG_SUPPORT=y
182  CONFIG_MTK_CMDQ=y
183  CONFIG_MTK_CMDQ_TAB=y
184  CONFIG_MTK_GPU_SUPPORT=y
185  CONFIG_MTK_GPU_VERSION="rgx clark 1.7ED"
186  CONFIG_MTK_GPU_COMMON_DVFS_SUPPORT=y
187  CONFIG_MTK_IMGSENSOR=y
188  CONFIG_MTK_LCM=y
189  CONFIG_CUSTOM_KERNEL_LCM="otm1287_wxga_dsi_vdo_auo_guoxian"
190  CONFIG_MTK_LENS=y
191  CONFIG_MTK_LENS_DUMMYLENS_SUPPORT=y
192  CONFIG_MTK_LENS_WV511AAF_SUPPORT=y
193  CONFIG_MTK_SYNC=y
194  CONFIG_MTK_VIDEOCODEC_DRIVER=y
195  CONFIG_MTK_FB=y
196  CONFIG_MTK_VIDEOX=y
197  CONFIG_MTK_LCM_PHYSICAL_ROTATION="0"
198  CONFIG_LCM_HEIGHT="1280"
199  CONFIG_LCM_WIDTH="800"
200  CONFIG_MTK_AAL_SUPPORT=y
201  CONFIG_MTK_SENSOR_SUPPORT=y
```

Set lcm width&height&rotation

MIPI DSI Panel case study

DSI Panel case study (1/x)

- LCM driver file need these functions
  - Init_power & resume_power & suspend_power are option
  - If use video mode, update function is option

```
568  LCM_DRIVER otm1287_wxga_dsi_vdo_auo_guoxian_lcm_drv = {
569      .name       = "otm1287_wxga_dsi_vdo_auo_guoxian",
570      .set_util_funcs = lcm_set_util_funcs,
571      .get_params     = lcm_get_params,
572      .init           = lcm_init_lcm,
573      .suspend        = lcm_suspend,
574      .resume         = lcm_resume,
575  /* .esd_check      = lcm_esd_check, */
576  /* .esd_recover = lcm_esd_recover, */
577  #if (LCM_DSI_CMD_MODE)
578      /*.set_backlight    = lcm_setbacklight,*/
579      /* .set_pwm        = lcm_setpwm, */
580      /* .get_pwm        = lcm_getpwm, */
581      /*.update         = lcm_update, */
582  #endif
583  };
```

DSI Panel case study (2/x)

- Lcm_get_params
  - Fill dsi mode & video timing & PLL_CLOCK params

```
461  #define FRAME_WIDTH  (800)
462  #define FRAME_HEIGHT (1280)
485  #if (LCM_DSI_CMD_MODE)
486      params->dsi.mode   = CMD_MODE;
487  #else
488      params->dsi.mode   = BURST_VDO_MODE;
489  #endif
490      /* DSI */
491      /* Command mode setting */
492      params->dsi.LANE_NUM                = LCM_FOUR_LANE;
503      params->dsi.vertical_sync_active                = 4;/* 2; */
504      params->dsi.vertical_backporch                  = 12;/* 16; */
505      params->dsi.vertical_frontporch                 = 20;/* 9; */
506      params->dsi.vertical_active_line                = FRAME_HEIGHT;
507      params->dsi.horizontal_sync_active              = 20;/* 42; */
508      params->dsi.horizontal_backporch                = 20;/* 42; */
509      params->dsi.horizontal_frontporch               = 30;/* 69; */
510      params->dsi.horizontal_active_pixel             = FRAME_WIDTH;
513      params->dsi.PLL_CLOCK   = 205;
```

DSI Panel case study (3/x)

- LCM init code
  - Please get LCM init code from vendor if need
  - Fill params in struct LCM_setting_table
    - Format { add, data num, {data}}
  - Use dsi_set_comq_V2 function push lcm init code

```
{0xBB,1,{0x10}},
```

```
static void push_table(struct LCM_setting_table *table,
{
    unsigned int i;

    for(i = 0; i < count; i++)
    {
        unsigned cmd;
        cmd = table[i].cmd;

        switch (cmd) {

            case REGFLAG_DELAY :
                if(table[i].count <= 10)
                    MDELAY(table[i].count);
                else
                    MDELAY(table[i].count);
                break;

            case REGFLAG_END_OF_TABLE :
                break;

            default:
                dsi_set_cmdq_V2(cmd, table[i].count, table[
        }
    } ? end for i=0;i<count;i++ ?
```

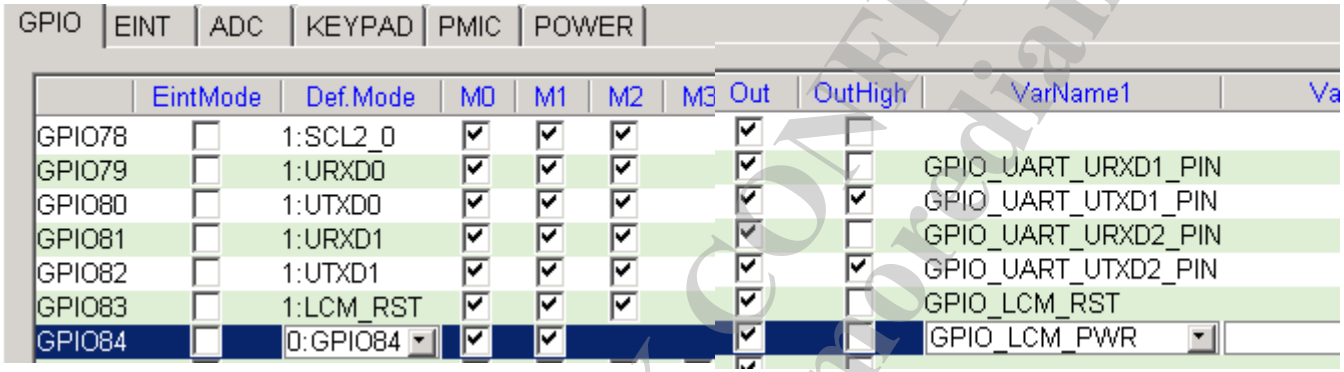
```
struct LCM_setting_table {
    unsigned char cmd;
    unsigned char count;
    unsigned char para_list[64];
};

static struct LCM_setting_table lcm_suspend_setting[] = {
    {0x28,0,{}},
    {0x10,0,{}},
    {REGFLAG_DELAY, 120, {}}
};

//update initial param for IC nt35520 0.01
static struct LCM_setting_table lcm_initialization_setting[] = {
    {0xFF,1,{0x10}},    //  Return  To  CMD1
    {REGFLAG_DELAY, 2, {}},
#if (LCM_DSI_CMD_MODE)
    {0xBB,1,{0x10}},
#else
    {0xBB,1,{0x03}},
#endif
    {0x3B,5,{0x03,0x0A,0x0A,0x0A,0x0A}},
```

DSI Panel case study LK (1/x)

- LCM power setting in lk
  - Update lcm power gpio in dct table



  - Use varname in lcm driver

```
#ifdef GPIO_LCM_PWR_EN
#define GPIO_LCD_PWR_EN      GPIO_LCM_PWR_EN
#else
#define GPIO_LCD_PWR_EN      0xFFFFFFFF
#endif

#ifdef GPIO_LCM_RST
#define GPIO_LCD_RST      GPIO_LCM_RST
#else
#define GPIO_LCD_RST      0xFFFFFFFF
#endif
```

DSI Panel case study LK (2/x)

- LCM power setting in lk
  - Use gpio api power on/off

```
static void lcm_set_gpio_output(unsigned int GPIO, unsigned int output)
{
    mt_set_gpio_mode(GPIO, GPIO_MODE_00);
    mt_set_gpio_dir(GPIO, GPIO_DIR_OUT);
    mt_set_gpio_out(GPIO, (output>0)? GPIO_OUT_ONE: GPIO_OUT_ZERO);
}
```

```
static void lcm_init_power(void)
{
#ifdef BUILD_LK
    printf("[LK/LCM] lcm_init_power() enter\n");

    lcm_set_gpio_output(GPIO_LCD_PWR_EN, GPIO_OUT_ONE);
    lcm_Enable_HW(1800);
    MDELAY(1);
#else
    printk("[Kernel/LCM] lcm_init_power() enter\n");

#endif

}

static void lcm_suspend_power(void)
{
#ifdef BUILD_LK
    printf("[LK/LCM] lcm_suspend_power() enter\n");
    lcm_set_gpio_output(GPIO_LCD_PWR_EN, GPIO_OUT_ZERO);
    MDELAY(20);
    lcm_Disable_HW();
#else
```

DSI Panel case study LK (4/x)

- LCM power setting in lk
  - Use pmic api power on/off

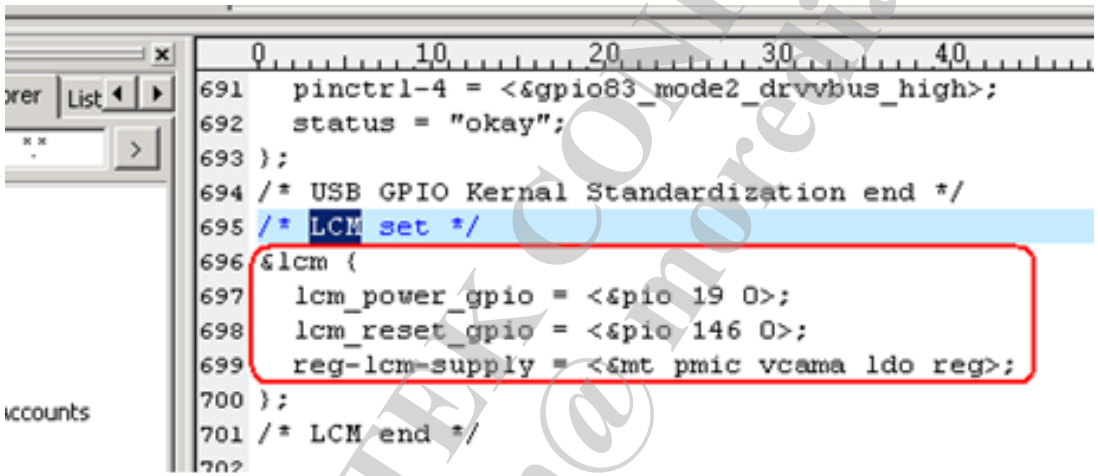
```
static void lcm_init_power(void)
{
#ifdef BUILD_LK
    printf("[LK/LCM] lcm_init_power() enter\n");
    lcm_set_gpio_output(GPIO_LCD_PWR, GPIO_OUT_ONE);
    MDELAY(20);
    upmu_set_rg_vgp3_vosel(3);
    upmu_set_rg_vgp3_en(0x1);
#else
    pr_debug("[Kernel/LCM] lcm_init_power() enter\n");
#endif
}
```

```
static void lcm_suspend_power(void)
{
#ifdef BUILD_LK
    printf("[LK/LCM] lcm_suspend_power() enter\n");
    lcm_set_gpio_output(GPIO_LCD_PWR, GPIO_OUT_ZERO);
    MDELAY(20);

    upmu_set_rg_vgp3_vosel(0);
    upmu_set_rg_vgp3_en(0x0);
```

DSI Panel case study Kernel-4.4 (1/x)

- LCM power setting in kernel-4.4
  - update lcm gpio&vgp setting in project.dts file



DSI Panel case study Kernel-4.4 (2/x)

- LCM power setting in kernel-4.4
  - Register lcm driver

```
437 static int __init lcm_init(void)
438 {
439     if (platform_driver_register(&lcm_driver)) {
440         pr_err("LCM: failed to register this driver!\n");
441         return -ENODEV;
442     }
443
444     return 0;
445 }
446
447 static void __exit lcm_exit(void)
448 {
449     platform_driver_unregister(&lcm_driver);
450 }
451
452 late_initcall(lcm_init);
453 module_exit(lcm_exit);
454 MODULE_AUTHOR("mediatek");
455 MODULE_DESCRIPTION("LCM display subsystem driver");
456 MODULE_LICENSE("GPL");
```

```
406 static const struct of_device_id lcm_platform_of_match[] = {
407     {
408         .compatible = "otm,otm1287_wxga_dsi_vdo_auo_guoxian",
409         .data = 0,
410     }, {
411         /* sentinel */
412     }
413 };
414
415 MODULE_DEVICE_TABLE(of, platform_of_match);
416
417 static int lcm_platform_probe(struct platform_device *pdev)
418 {
419     const struct of_device_id *id;
420
421     id = of_match_node(lcm_platform_of_match, pdev->dev.of_node);
422     if (!id)
423         return -ENODEV;
424
425     return lcm_driver_probe(&pdev->dev, id->data);
426 }
427
428 static struct platform_driver lcm_driver = {
429     .probe = lcm_platform_probe,
430     .driver = {
431             .name = "otm1287_wxga_dsi_vdo_auo_guoxian",
432             .owner = THIS_MODULE,
433             .of_match_table = lcm_platform_of_match,
434     },
435 };
```

DSI Panel case study Kernel-4.4 (3/x)

- LCM power setting in kernel-4.4
  - Get lcm node from project.dts

```
static struct regulator *lcm_vgp;
static unsigned int GPIO_LCD_PWR_EN;
static unsigned int GPIO_LCD_RST_EN;

void lcm_get_gpio_infor(void)
{
    static struct device_node *node;

    node = of_find_compatible_node(NULL, NULL, "mediatek,lcm");

    GPIO_LCD_PWR_EN = of_get_named_gpio(node, "lcm_power_gpio", 0);
    GPIO_LCD_RST_EN = of_get_named_gpio(node, "lcm_reset_gpio", 0);
}

static int lcm_get_vgp_supply(struct device *dev)
{
    int ret;
    struct regulator *lcm_vgp_ldo;

    pr_debug("LCM: lcm_get_vgp_supply is going\n");

    lcm_vgp_ldo = devm_regulator_get(dev, "reg-lcm");
    if (IS_ERR(lcm_vgp_ldo)) {
        ret = PTR_ERR(lcm_vgp_ldo);
        dev_err(dev, "failed to get reg-lcm LDO, %d\n", ret);
        return ret;
    }

    pr_debug("LCM: lcm get supply ok.\n");

    /* get current voltage settings */
    ret = regulator_get_voltage(lcm_vgp_ldo);
    pr_debug("lcm LDO voltage = %d in LK stage\n", ret);

    lcm_vgp = lcm_vgp_ldo;

    return ret;
} ? end lcm_get_vgp_supply ?
```

DSI Panel case study Kernel-4.4 (4/x)

- LCM power setting in kernel-4.4
  - Use gpio api pull high /low

```
static void lcm_set_gpio_output(unsigned int GPIO, unsigned int output)
{
    gpio_direction_output(GPIO, output);
    gpio_set_value(GPIO, output);
}

static void lcm_init_lcm(void)
{
    lcm_vgp_supply_enable();
    lcm_set_gpio_output(GPIO_LCD_PWR_EN, 1);
    lcm_set_gpio_output(GPIO_LCD_RST_EN, 1);
    SET_RESET_PIN(1);
    lcm_set_gpio_output(GPIO_LCD_RST_EN, 0);
    SET_RESET_PIN(0);
    MDELAY(10);
    lcm_set_gpio_output(GPIO_LCD_RST_EN, 1);
    SET_RESET_PIN(1);
    MDELAY(100);
    push_table(lcm_initialization_setting,
            sizeof(lcm_initialization_setting) / s
}

static void lcm_suspend(void)
{
    /*push_table(lcm_deep_sleep_mode_in_setting,
            sizeof(lcm_deep_sleep_mode_in_setting) / size
    lcm_set_gpio_output(GPIO_LCD_PWR_EN, 0);
    lcm_vgp_supply_disable();
    SET_RESET_PIN(0);
```

```
static void lcm_resume(void)
{
    lcm_init_lcm();
}
```

DSI Panel case study Kernel-4.4 (5/x)

- LCM power setting in kernel-4.4
  - Use pmic api power on/off

```
static void lcm_init_lcm(void)
{
    lcm_vgp_supply_enable();
    lcm_set_gpio_output(GPIO_LCD_PWR_EN, 1);
    lcm_set_gpio_output(GPIO_LCD_RST_EN, 1);
    SET_RESET_PIN(1);
    lcm_set_gpio_output(GPIO_LCD_RST_EN, 0);
    SET_RESET_PIN(0);
    MDELAY(10);
    lcm_set_gpio_output(GPIO_LCD_RST_EN, 1);
    SET_RESET_PIN(1);
    MDELAY(100);
    push_table(lcm_initialization_setting,
            sizeof(lcm_initialization_setting) / s
}

static void lcm_suspend(void)
{
    /*push_table(lcm_deep_sleep_mode_in_setting,
            sizeof(lcm_deep_sleep_mode_in_setting) / size
    lcm_set_gpio_output(GPIO_LCD_PWR_EN, 0);
    lcm_vgp_supply_disable();
    SET_RESET_PIN(0);

static void lcm_resume(void)
{
    lcm_init_lcm();
}
```

```
int lcm_vgp_supply_enable(void)
{
    int ret;
    unsigned int volt;

    pr_debug("LCM: lcm_vgp_supply_enable\n");

    if (NULL == lcm_vgp)
        return 0;

    pr_debug("LCM: set regulator voltage lcm_vgp voltage to 1.8V\n");
    /* set voltage to 1.8V */
    ret = regulator_set_voltage(lcm_vgp, 1800000, 1800000);
    if (ret != 0) {
        pr_err("LCM: lcm failed to set lcm_vgp voltage: %d\n", ret);
        return ret;
    }
```

```
int lcm_vgp_supply_disable(void)
{
    int ret = 0;
    unsigned int isenable;

    if (NULL == lcm_vgp)
        return 0;

    /* disable regulator */
    isenable = regulator_is_enabled(lcm_vgp);

    pr_debug("LCM: lcm query regulator enable status[0x%

    if (isenable) {
        ret = regulator_disable(lcm_vgp);
        if (ret != 0) {
            pr_err("LCM: lcm failed to disable lcm_vgp:
            return ret;
        }
        /* verify */
        isenable = regulator_is_enabled(lcm_vgp);
        if (!isenable)
            pr_err("LCM: lcm regulator disable pass\n");
    }
```

DSI Panel case study ESD

- ESD issue please try：
  - If FAQ14251 isn’t work please add below params to set clock to LP

```
params->dsi.clk_lp_per_line_enable = 1;
params->dsi.noncont_clock = 0;
```

DSI Panel case study reference file

- Vendor/mediatek/proprietary/bootable/bootloader/lk/dev/lcm/otm1287_wxga_dsi_vdo_auo_guoxian /otm1287_wxga_dsi_vdo_auo_guoxian .c
- Kernel-4.4/drivers/misc/mediatek/lcm/otm1287_wxga_dsi_vdo_auo_guoxian /otm1287_wxga_dsi_vdo_auo_guoxian .c
- Kernel-4.4/arch/arm64/boot/dts/tb8183m1_64.dts

LVDS LCM driver

```
LCM_DRIVER clap070wp03xg_lvds_8163_lcm_drv =
{
    .name           = "clap070wp03xg_lvds_8163",
    .set_util_funcs = lcm_set_util_funcs,
    .get_params     = lcm_get_params,
    .init           = lcm_init,
    .suspend        = lcm_suspend,
    .resume         = lcm_resume,
    .init_power     = lcm_init_power,
    .resume_power   = lcm_resume_power,
    .suspend_power  = lcm_suspend_power,
};
```


Step1：implement driver（1/x）

- Implement LCM params refer to lcm spec: width& hight

```
#define FRAME_WIDTH  (800)
#define FRAME_HEIGHT (1280)


static void lcm_get_params(LCM_PARAMS *params)
{
    memset(params, 0, sizeof(LCM_PARAMS));

    params->type   = LCM_TYPE_DPI;
    params->width  = FRAME_WIDTH;
    params->height = FRAME_HEIGHT;

    params->dpi.width = FRAME_WIDTH;
    params->dpi.height = FRAME_HEIGHT;
```

Add for DPI

Step2：implement driver（2/x）

- Implement LCM params refer to lcm spec: timing &clock

(2) Timing Chart

ITEM				SYNBOL	MIN	TYP	MAX	UNIT
LCD Timing	Frame Rate			-	-	60	-	Hz
	DCLK		Frequency	f_{CLK}	-	66.77	Clock	MHz
	DENA	Horizontal	Horizontal total time	t_H	-	864	-	t_{CLK}
			Horizontal Active time	t_{HA}	-	800	-	t_{CLK}
			Horizontal Blank time	t_{HB}	-	64	-	t_{CLK}
		Vertical	Vertical total time	t_V	-	1288	timing	t_H
			Vertical Active time	t_{VA}	-	1200	-	t_H
			Vertical Blank time	t_{VB}	-	8	-	t_H

```
params->dpi.clk_pol           = LCM_POLARITY_FALLING;
params->dpi.de_pol            = LCM_POLARITY_RISING;
params->dpi.vsync_pol         = LCM_POLARITY_FALLING;
params->dpi.hsync_pol         = LCM_POLARITY_FALLING;

params->dpi.hsync_pulse_width = HSYNC_PULSE_WIDTH;
params->dpi.hsync_back_porch  = HSYNC_BACK_PORCH;
params->dpi.hsync_front_porch = HSYNC_FRONT_PORCH;
params->dpi.vsync_pulse_width = VSYNC_PULSE_WIDTH;
params->dpi.vsync_back_porch  = VSYNC_BACK_PORCH;
params->dpi.vsync_front_porch = VSYNC_FRONT_PORCH;

params->dpi.PLL_CLOCK = 67;  //67MHz
```

```
#define HSYNC_PULSE_WIDTH 16
#define HSYNC_BACK_PORCH  16
#define HSYNC_FRONT_PORCH 32
#define VSYNC_PULSE_WIDTH 2
#define VSYNC_BACK_PORCH  2
#define VSYNC_FRONT_PORCH 4
```

Step3：implement driver（3/x）

- Implement LCM params refer to lcm spec: color format

```
params->dpi.format              = LCM_DPI_FORMAT_RGB888;    // format is 24 bit
params->dpi.rgb_order           = LCM_COLOR_ORDER_RGB;
```

- Enable LVDS

```
params->dpi.lvds_tx_en = 1;
```

```
LCM_DRIVER clap070wp03xg_lvds_8163_lcm_drv =
{
    .name           = "clap070wp03xg_lvds_8163",
    .set_util_funcs = lcm_set_util_funcs,
    .get_params     = lcm_get_params,
    .init           = lcm_init,
    .suspend        = lcm_suspend,
    .resume         = lcm_resume,
    .init_power     = lcm_init_power,
    .resume_power   = lcm_resume_power,
    .suspend_power  = lcm_suspend_power,
};
```

RGB LCM driver

Step1：implement driver（1/x）

- Implement LCM params refer to lcm spec: width& hight

```
#define FRAME_WIDTH  (600)
#define FRAME_HEIGHT (1024)


static void lcm_get_params(LCM_PARAMS *params)
{
    memset(params, 0, sizeof(LCM_PARAMS));

    params->type   = LCM_TYPE_DPI;
    params->width  = FRAME_WIDTH;
    params->height = FRAME_HEIGHT;

    params->dpi.width = FRAME_WIDTH;
    params->dpi.height = FRAME_HEIGHT;
```

Add for DPI

Step2：implement driver（2/x）

- Implement LCM params refer to lcm spec: timing &clock
- We support DE MODE&SYNC MODE both of them, you can choose one for setting

6.1 Input Timing Table

	ITEM	SYMBOL	MIN.	TYP.	MAX.	UNIT	Note
DE MODE	Dot Clock	1/tCLK	45	51.2	57	MHz	Clock
	DCLK Pulse Duty	Tcwh	40	50	60	%	
	Horizontal Total Time	tH	1324	1344	1364	tCLK	
	Horizontal Effective Time	tHA		1024		tCLK	
	Horizontal Blank Time	tHB	300	320	340	tCLK	timing
	Vertical Total Time	tV	625	635	645	tH	
	Vertical Effective Time	tVA		600		tH	
	Vertical Blank Time	tVB	25	35	45	tH	
SYNC MODE	Horizontal Total Time	TH	1324	1344	1364	tCLK	
	Horizontal Pulse Width	Thpw		20	-	tCLK	thb + thpw =160DCLK is fixed
	Horizontal Back Porch	Thb		140	-	tCLK	
	Horizontal Front Porch	Thfp	140	160	180	tCLK	
	Horizontal Effective Time	THA		1024		tCLK	
	Vertical Total Time	TV	625	635	645	tH	timing
	Vertical Pulse Width	Tvpw		3	-	th	tvpw + tvb =23th is fixed
	Vertical Back Porch	Tvb	-	20	-	th	
	Vertical Front Porch	Tvfp	2	12	22	th	
	Vertical Valid	Tvd		600		th	

```
params->dpi.clk_pol           = LCM_POLARITY_FALLING;
params->dpi.de_pol            = LCM_POLARITY_RISING;
params->dpi.vsync_pol         = LCM_POLARITY_FALLING;
params->dpi.hsync_pol         = LCM_POLARITY_FALLING;

params->dpi.hsync_pulse_width = HSYNC_PULSE_WIDTH;
params->dpi.hsync_back_porch  = HSYNC_BACK_PORCH;
params->dpi.hsync_front_porch = HSYNC_FRONT_PORCH;
params->dpi.vsync_pulse_width = VSYNC_PULSE_WIDTH;
params->dpi.vsync_back_porch  = VSYNC_BACK_PORCH;
params->dpi.vsync_front_porch = VSYNC_FRONT_PORCH;
```

```
#define HSYNC_PULSE_WIDTH 16
#define HSYNC_BACK_PORCH  16
#define HSYNC_FRONT_PORCH 32
#define VSYNC_PULSE_WIDTH 2
#define VSYNC_BACK_PORCH  2
#define VSYNC_FRONT_PORCH 4
```

```
params->dpi.PLL_CLOCK = 51;
```

Step3：implement driver（3/x）

- Only support RGB666 because of HW limitation

```
params->dpi.format              = LCM_DPI_FORMAT_RGB666;
params->dpi.rgb_order           = LCM_COLOR_ORDER_RGB;
```

- RGB driving current : 4mA/8mA/12mA/16mA, default: 8mA
- Set driving current in LK:

```
#ifdef BUILD_LK
    params->dpi.io_driving_current = LCM_DRIVING_CURRENT_8MA;
#endif
```

- Set driving current in kernel-4.4, please modify dts file

```
571             <MT8167_PIN_6_EINT6__FUNC_DPI_D17>;
572             drive-strength = <MTK_DRIVE_4mA>;
573         };
574     };
```

- Disable LVDS

```
params->dpi.lvds_tx_en = 0;
```

Step4：implement driver（4/x）

- Implement GPIO & DPI function in LK DWS file

GPIO83	☐	1:LCM_RST	☑	☑		☑	☑	☐	☑	☑	☐	GPIO_LCM_RST
GPIO84	☐	0:GPIO84	☑	☑		☑	☑	☐	☑	☑	☐	GPIO_LCM_PWR

GPIO | EINT | ADC | KEYPAD | PMIC | POWER

	EintMode	Def.Mode	M0	M1	M2	M3	M4	M5	M6	M7	InPull ...	InPull ...	In	Out	OutHigh
GPIO14	☐	2:DPI_D5	☐	☐	☑	☐	☐	☐	☐		☐	☐			☐
GPIO15	☐	2:DPI_HSYNC	☐	☐	☑	☐	☐	☐	☐		☐	☐			☐
GPIO16	☐	2:DPI_DE	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐			☐
GPIO17	☐	2:DPI_VSYNC	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐			☐
GPIO18	☐	2:DPI_D4	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐			☐
GPIO19	☐	2:DPI_D3	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐			☐
GPIO20	☐	2:DPI_D1	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐			☐
GPIO21	☐	2:DPI_D2	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐			☐
GPIO22	☐	2:DPI_CK	☐	☐	☑		☐	☐		☐	☐	☐			☐
GPIO23	☐	2:DPI_D12	☐	☐	☑		☐	☐		☐	☐	☐			☐
GPIO24	☐	2:DPI_D13	☐	☐	☑		☐	☐		☐	☐	☐			☐
GPIO25	☐	2:DPI_D14	☐	☐	☑	☐	☐	☐		☐	☐	☐			☐
GPIO26	☐	2:DPI_D15	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐			☐
GPIO27	☐	2:DPI_D16	☐	☐	☑	☐	☐	☐		☐	☐	☐			☐
GPIO28	☐	2:DPI_D17	☐	☐	☑	☐	☐	☐		☐	☐	☐			☐
GPIO29	☐	2:DPI_D6	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐			☐
GPIO30	☐	6:DPI_D7	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐			☐
GPIO31	☐	6:DPI_D8	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐			☐
GPIO32	☐	6:DPI_D9	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐			☐
GPIO43	☐	5:DPI_D10	☐	☐	☐		☐	☑	☐	☐	☐	☐			☐
GPIO44	☐	5:DPI_D11	☐	☐	☐		☐	☑	☐	☐	☐	☐			☐
GPIO45	☐	5:DPI_D0	☐			☐	☐	☑	☐	☐	☐	☐			☐

Step5：implement driver（5/x）

- Implement DPI function in Kernel-4.4 project dts file

tb8167p3_64.dts

```
543                     <MT8167_PIN_61_SCL2__FUNC_SCL2_0>;
544                 bias-disable;
545             };
546         };
547
548         dpi_pins_default: dpi_pins_default {
549             pins_cmd_dat {
550                 pins = <MT8167_PIN_0_EINT0__FUNC_DPI_CK>,
551                 <MT8167_PIN_24_EINT24__FUNC_DPI_DE>,
552                 <MT8167_PIN_25_EINT25__FUNC_DPI_VSYNC>,
553                 <MT8167_PIN_35_UTXD2__FUNC_DPI_HSYNC>,
554                 <MT8167_PIN_13_EINT13__FUNC_DPI_D0>,
555                 <MT8167_PIN_38_MRG_DI__FUNC_DPI_D1>,
556                 <MT8167_PIN_39_MRG_DO__FUNC_DPI_D2>,
557                 <MT8167_PIN_37_MRG_SYNC__FUNC_DPI_D3>,
558                 <MT8167_PIN_36_MRG_CLK__FUNC_DPI_D4>,
559                 <MT8167_PIN_34_URXD2__FUNC_DPI_D5>,
560                 <MT8167_PIN_7_EINT7__FUNC_DPI_D6>,
561                 <MT8167_PIN_8_EINT8__FUNC_DPI_D7>,
562                 <MT8167_PIN_9_EINT9__FUNC_DPI_D8>,
563                 <MT8167_PIN_10_EINT10__FUNC_DPI_D9>,
564                 <MT8167_PIN_11_EINT11__FUNC_DPI_D10>,
565                 <MT8167_PIN_12_EINT12__FUNC_DPI_D11>,
566                 <MT8167_PIN_1_EINT1__FUNC_DPI_D12>,
567                 <MT8167_PIN_2_EINT2__FUNC_DPI_D13>,
568                 <MT8167_PIN_3_EINT3__FUNC_DPI_D14>,
569                 <MT8167_PIN_4_EINT4__FUNC_DPI_D15>,
570                 <MT8167_PIN_5_EINT5__FUNC_DPI_D16>,
571                 <MT8167_PIN_6_EINT6__FUNC_DPI_D17>;
572                 drive-strength = <MTK_DRIVE_4mA>;
573             };
574         };
```

```
76      panel: panel@0 {
77          compatible = "kd,kd070d5450nha6";
78          pinctrl-names = "default";
79          pinctrl-0 = <&dpi_pins_default>;
80          gpio_lcd_pwr = <&pio 50 0>;
81          gpio_lcd_rst = <&pio 70 0>;
82          reg-lcm-supply = <&mt6392_vgp2_reg>;
83          status = "okay";
84      };
85
```

everyday genius