EC2x-QuecOpen Aboot

Adding SPI Multicolored Display Guide

LTE Standard Module Series

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About the Document

History

Revision	Date	Author	Description
1.0	2018-07-04	Matthew MA	Initial
1.1	2019-03-14	Matthew MA	Updated and improved the document format.

Contents

1 Introduction

This document mainly introduces how to add and adapt one SPI LCD colored screen to Open Linux Aboot from the user's development perspective. Here LCD driver codes take TFT for example.

This document mainly applies to global market, and supports the LTE Standard modules currently included:

- EC2x: EC20 R2.1/EC25/EC21

2 Preparation

Prepare the SDK compilation environment under Linux, and complete *lk(aboot)* compilation.

2.1. Compiling Aboot under Open Linux

Prepare compilation environment:

```
# source ql-ol-crosstool/ql-ol-crosstool-env-init
```

Compile Aboot:

```
# make aboot
```

Check Aboot image after compilation:

```
# ls target/appsboot.mbn
```

```
Makefile  ql-ol-bootloader  ql-ol-crosstool  ql-ol-extsdk  ql-ol-kernel  ql-ol-rootfs  ql-ol-usrdata  target
ol@ol-OptiPlex-7050:~/sdk/cefdlg/ql-ol-sdk$ source ql-ol-crosstool/ql-ol-crosstool-env-init
QUECTEL_PROJECT_NAME      =EC20CE_FDLG
QUECTEL_PROJECT_REV       =EC20CEFDLGR06A03M1G_OCPU
QUECTEL_FEATURE_OPENLINUX =OL
ol@ol-OptiPlex-7050:~/sdk/cefdlg/ql-ol-sdk$ make aboot
cd /home/ol/sdk/cefdlg/ql-ol-sdk/ql-ol-bootloader ; make -j 4 mdm9607  TOOLCHAIN_PREFIX=arm-oe-linux-gnueabi- SIGNED_KERNEL=1 || exit ; \
cp build-mdm9607/appsboot.mbn /home/ol/sdk/cefdlg/ql-ol-sdk/target
make[1]: Entering directory '/home/ol/sdk/cefdlg/ql-ol-sdk/ql-ol-bootloader'
make[2]: Entering directory '/home/ol/sdk/cefdlg/ql-ol-sdk/ql-ol-bootloader'
including app/aboot dev/keys dev/pmic/pm8x41 dev/vib lib/debug lib/heap lib/libc lib/libfdt lib/openssl lib/ptable
including lib/openssl/crypto lib/zlib_inflate
generating build-mdm9607/config.h
generating build-mdm9607/system-onesegment.ld
linking build-mdm9607/lk
generating image: build-mdm9607/lk.bin
generating listing: build-mdm9607/lk.debug.lst
generating symbols: build-mdm9607/lk.sym
generating listing: build-mdm9607/lk.lst
   text    data     bss     dec     hex filename
 265660  105240   77300  448200   6d6c8 build-mdm9607/lk
arm-oe-linux-gnueabi-objcopy -O binary build-mdm9607/lk build-mdm9607/lk.bin
generating size map: build-mdm9607/lk.size
generating stripped elf: build-mdm9607/lk_s.elf
cp ./build-mdm9607/lk.bin ./build-mdm9607/appsboot.raw
cp -f ./build-mdm9607/lk_s.elf ./build-mdm9607/appsboot.mbn
make[2]: Leaving directory '/home/ol/sdk/cefdlg/ql-ol-sdk/ql-ol-bootloader'
make[1]: Leaving directory '/home/ol/sdk/cefdlg/ql-ol-sdk/ql-ol-bootloader'
ol@ol-OptiPlex-7050:~/sdk/cefdlg/ql-ol-sdk$ ls
Makefile  ql-ol-bootloader  ql-ol-crosstool  ql-ol-extsdk  ql-ol-kernel  ql-ol-rootfs  ql-ol-usrdata  target
ol@ol-OptiPlex-7050:~/sdk/cefdlg/ql-ol-sdk$ ls target/
appsboot.mbn  mdm9607-perf-boot.img
ol@ol-OptiPlex-7050:~/sdk/cefdlg/ql-ol-sdk$
```

3 The Source Code for Aboot Adding Dot Matrix Screen

Multicolored display source code included following:

- LCD driver files: *lcd.c* and *lcd.h*
- Characters library files: *font.c* and *font.h*
- Logo file: *logo.c*
- Compilation file: *runles.mk*

3.1. Steps to Add

- Adding source code

Please extract 

provided by Quectel to *ql-ol-bootloader/dev*

- Adding LCD compilation

Modify *target/mdm9607/rules.mk*, and add as following:

```
MODULES += \
        dev/keys \
        dev/lcd\
        dev/vib \
        lib/ptable \
        dev/pmic/pm8x41 \
        lib/libfdt
```

- LCD display during initiating Aboot

Modify *kernel/main.c*

```
        dprintf(SPEW, "initializing target\n");
        target_init();

        dprintf(SPEW, "calling apps_init()\n");
/*****************************************************************************************
matthew-2018/11/28:avoid the splash screen
Refer to [Issue-Depot].[IS0000376][Submitter:matthew.ma,Date:2018-11-28]
<avoid the splash screen>
*****************************************************************************************/
        //matthew.ma 2018.9.17 press the power key at least 2s for boot
        if((pm8x41_get_is_cold_boot())&&(pm8x41_get_pon_reason()==64))
                if(0==ql_pm8x41_get_pwrkey_is_pressed())
                        shutdown_device();
/*****************************************************************************************
matthew-2018/10/12:lcd init and boot with logo
Refer to [Req-Depot].[RQ0000192][Submitter:matthew.ma,Date:2018-10-12]
<对讲机屏幕,开机logo和gui>
*****************************************************************************************/
        lcd_init();
        logo_update();
        show_image();
        LCD_Display_On();
        back_light();
//end matthew-2018/10/12
//end matthew 2018-11-28
        apps_init();

        return 0;
}
```

- Re-compiling Aboot in *ql-ol-sdk*

```
# make aboot
```

4 LCD Configuration

- LCD external pin configuration

Please check following definition in *lcd.h*

```
#include<pm8x41.h>

#define GPIO_RST                        2       //pin6
#define GPIO_RS                 3       //pin 139
#define GPIO_BL                 75
#define SPI_CLK                 23
#define SPI_CS                  22
#define SPI_OUT                 20
#define LCD_W                   160
#define LCD_H                   128
```

In which, the RST is the reset pin, RS is the command data selection pin, BL is the backlight pin. CLK, CS and OUT are SPI pins (modification is not recommended). LCD_W and LCD_H mean width and height of the LCD.

- Logo configuration in Aboot

There is an array to store Logo below *logo.c*, and its size depends on LCD's width and height. The color depth usually is 2.

```
const unsigned char gImage[LCD_W*LCD_H*2] = { /* 0X10,0X10,0X00,0XA0,0X00,0X80,0X01,0X1B, */
};
```

The data of this array can be generated via picture, please use the tool 

to generate Logo picture to display when startup.

Select the needed resolution ratio and save it as array, then copy the content from the saved array to *qImage* in *logo.c.*

NOTES

1. The software needs registration before use, or watermark image2lcd will be shown on LCD.
2. The image's resolution ratio and LCD's should be match, please configure it on image2lcd software.
3. The tool Image2lcd.exe mentioned above only has Chinese version, customers can download other similar tool in English to do above steps.

- LCD initialization sequence

The function *lcd_init* in *Lcd.c* has LCD initialization sequence, please set it according to specific screen sequence.

```
        LCD_RST_H;^M
        _delay_(20);^M
        LCD_RST_L;^M
        _delay_(20);^M
        LCD_RST_H;^M
        _delay_(20);^M
        LCD_CS_L;^M
        LCD_WR_REG(0x11);^M
        _delay_(120);^M
^M
LCD_WR_REG(0xB1);^M
LCD_WR_DATA8(0x05);^M
LCD_WR_DATA8(0x3A);^M
LCD_WR_DATA8(0x3A);^M
LCD_WR_REG(0xB2);^M
LCD_WR_DATA8(0x05);^M
LCD_WR_DATA8(0x3A);^M
LCD_WR_DATA8(0x3A);^M
LCD_WR_REG(0xB3);^M
LCD_WR_DATA8(0x05);^M
LCD_WR_DATA8(0x3A);^M
LCD_WR_DATA8(0x3A);^M
LCD_WR_DATA8(0x05);^M
LCD_WR_DATA8(0x3A);^M
LCD_WR_DATA8(0x3A);^M
//------------------------------------End ST7735S Frame Rate-----------------------------------------//^M
LCD_WR_REG(0xB4); //Dot inversion^M
LCD_WR_DATA8(0x03);^M
//------------------------------------ST7735S Power Sequence-----------------------------------------//^M
^M
LCD_WR_REG(0xC0); ^M
LCD_WR_DATA8(0x28); ^M
LCD_WR_DATA8(0x08); ^M
LCD_WR_DATA8(0x84); ^M
LCD_WR_REG(0xC1); ^M
LCD_WR_DATA8(0XC0); ^M
LCD_WR_REG(0xC2); ^M
LCD_WR_DATA8(0x0C); ^M
LCD_WR_DATA8(0x00); ^M
LCD_WR_REG(0xC3); ^M
LCD_WR_DATA8(0x8C); ^M
LCD_WR_DATA8(0x2A); ^M
```

5 Appendix A References

Table 1: Terms and Abbreviations

Abbreviation	Description
SPI	Serial Peripheral Interface
LCD	Liquid Crystal Display
LTE	Long Term Evolution
SDK	Software Development Kit
TFT	Thin Film Transistor