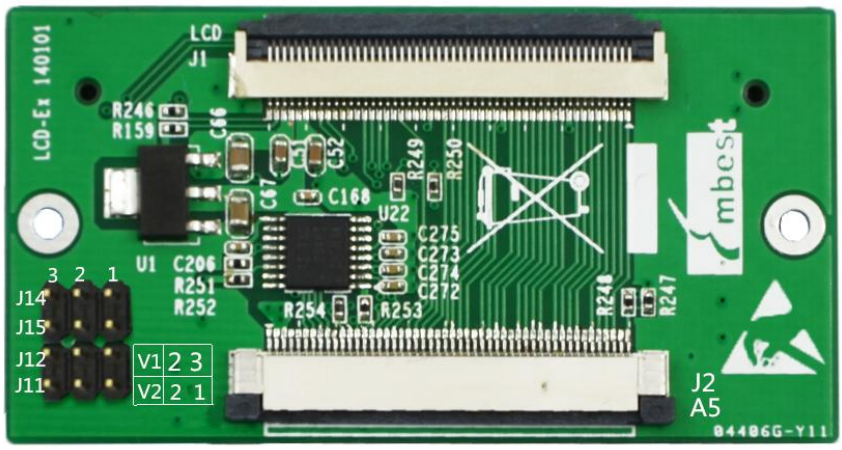
Quick Guide for
LCD-Ex Conversion Module

Rev.1.2

Release:2014-05-27



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Product Overview

1. Brief Introduction

LCD-EX is a 16/24-bit RGB parallel conversion module designed for TFT-LCD displays. The module integrates a TSC2046 chip for touch function and a 3.3V regulation chip with capability to implement IIC control and PWM backlight control. It supports 16-bit and 24-bit driving modes for LCD displays, as well as connecting SPI 4-wire resistive touch-screen..

2. Block Diagrams

The figure shown below is a block diagram that shows how LCD-EX works when using 16-bit logic interface.

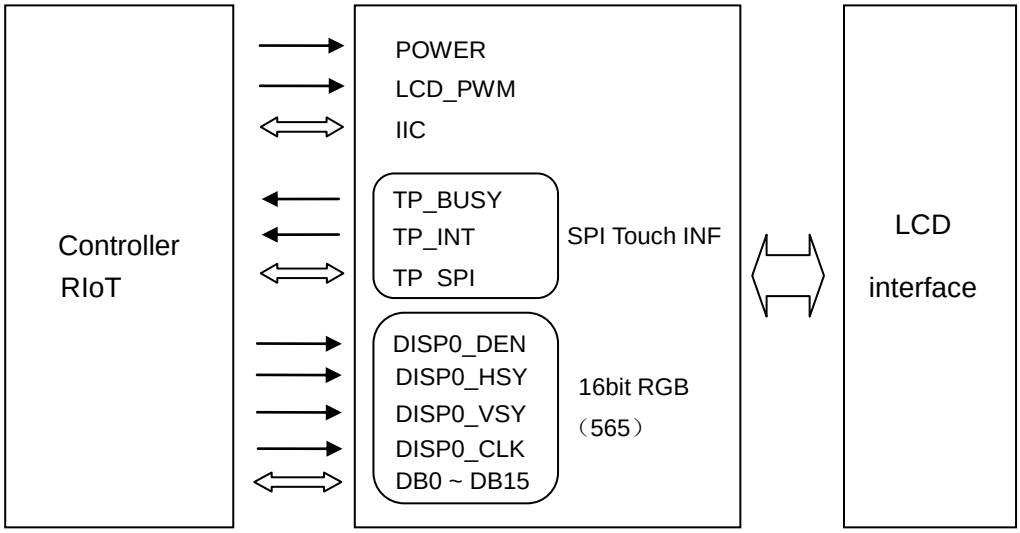

Figure 1 16-Bit Logic Interface

The figure shown below is a block diagram that shows how LCD-EX works when using 24-bit logic interface.

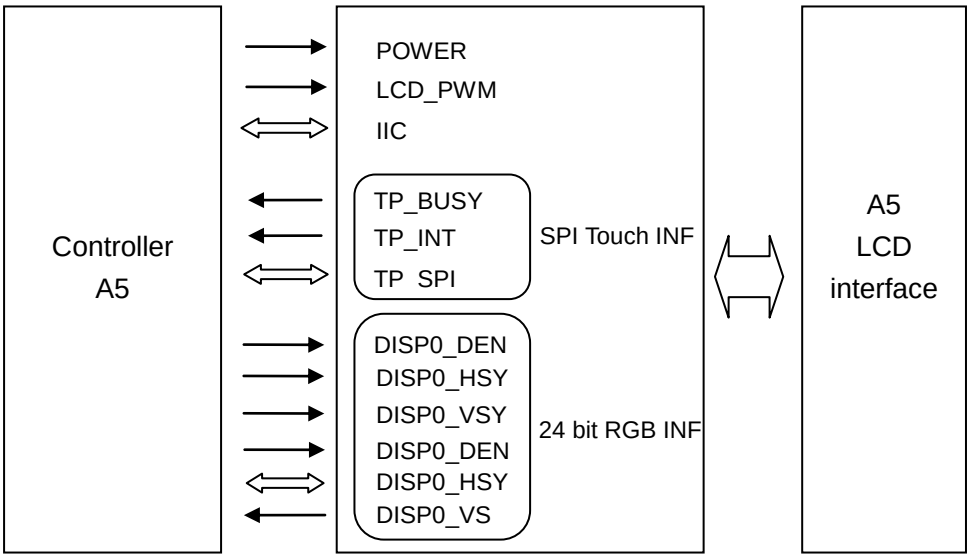

Figure 2 24-Bit Logic Interface

Interfaces on LCD-EX

1. Locations and Types of Interfaces

The following images shows locations of the interfaces on LCD-EX named J1, J2 and J13.

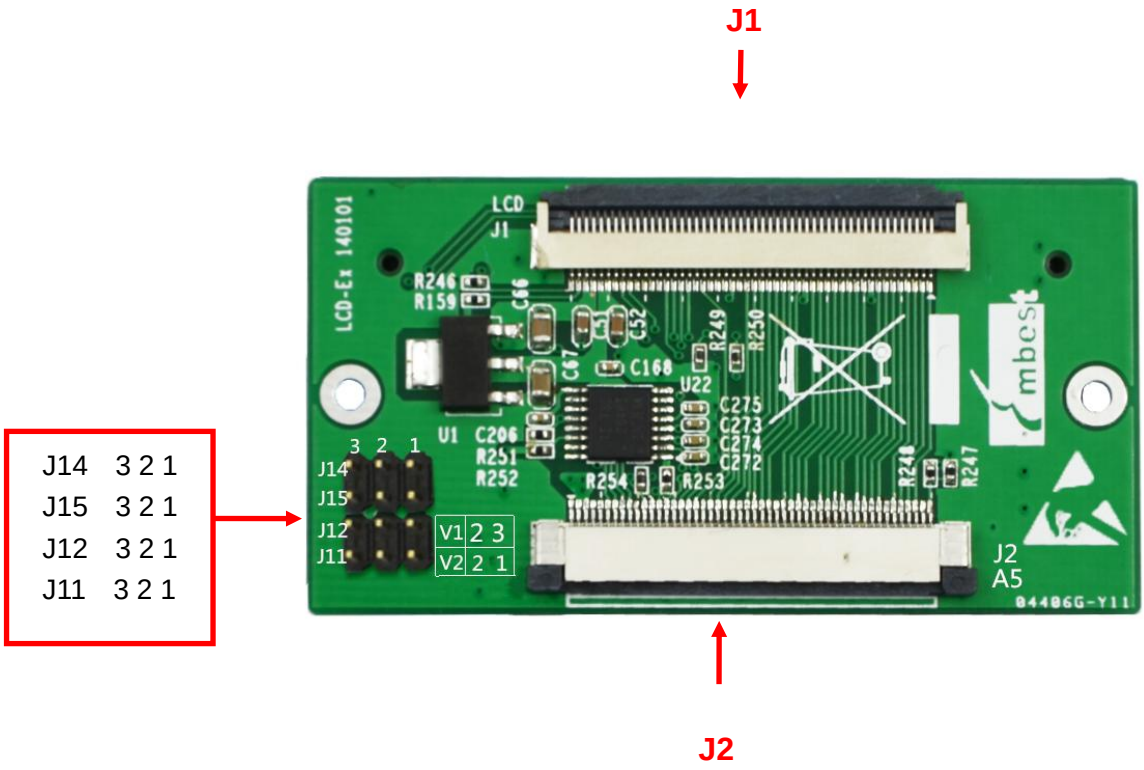

Figure 3 J1/J2 Interfaces

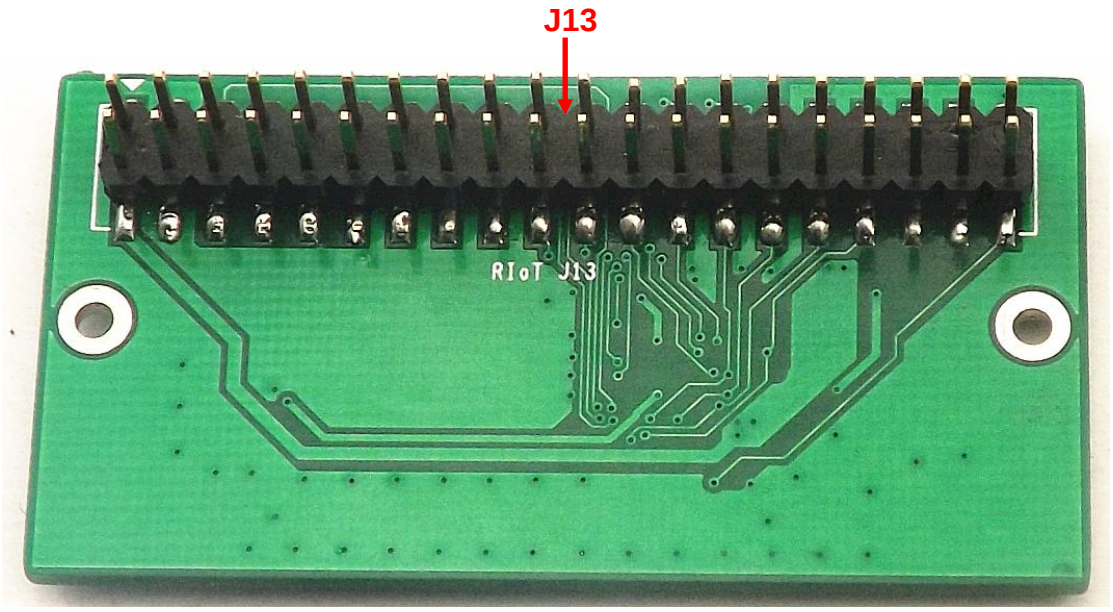

Figure 4 J13 Interface

The following table lists the brief descriptions of these interfaces.

Table 1 Interface Description

Names	Descriptions
J1	50-Pin interface for colored display
J2	24-bit RGB A5 interface
J13	16-bit 565 RIoT interface
J11	SPI line module Select
J12	
J14	
J15	

2. Pin Definitions of Interfaces

The following tables contain detailed information about these interfaces.

Table 2 Pin Definitions of J1

Pins	Definitions	Descriptions
1	B0	Blue Data0
2	B1	Blue Data1
3	B2	Blue Data2
4	B3	Blue Data3
5	B4	Blue Data4
6	B5	Blue Data5
7	B6	Blue Data6
8	B7	Blue Data7
9	GND	GND
10	G0	Green Data0
11	G1	Green Data1
12	G2	Green Data2
13	G3	Green Data3
14	G4	Green Data4
15	G5	Green Data5
16	G6	Green Data6
17	G7	Green Data7
18	GND	GND
19	R0	Red Data0
20	R1	Red Data1
21	R2	Red Data2

Pins	Definitions	Descriptions
22	R3	Red Data3
23	R4	Red Data4
24	R5	Red Data5
25	R6	Red Data6
26	R7	Red Data7
27	GND	GND
28	DEN	Pixel data enable (TFT)
29	HSYNC	LCD Horizontal Synchronization
30	VSYNC	LCD Vertical Synchronization
31	GND	GND
32	CLK	LCD Pixel Clock
33	GND	GND
34	X+	X+ Position Input
35	x-	X- Position Input
36	Y+	Y+ Position Input
37	Y-	Y - Position Input
38	SPI_CLK	SPI serial clock
39	SPI_MOSI	SPI Master Output, Slave Input
40	SPI_MISO	SPI Master Input, Slave Output
41	SPI_CS	SPI Chip Select
42	IIC_CLK	IIC master serial clock
43	IIC_DAT	IIC serial bidirectional data
44	GND	GND
45	VDD1	3.3V
46	VDD2	3.3V
47	VDD3	5V
48	VDD3	5V
49	RESET	Reset
50	PWREN	Backlight enable

Table 3 Pin Definitions of J2

Pins	Definitions	Descriptions
1	GND	GND
2	5V	VCC Input
3	5V	VCC Input
4	NC	NC
5	LCD_PWM	Backlight enable
6	TP_BUSY	Touch Pad Busy Signal
7	TP_INT	Touch Pad Interruput
8	I2C_CLK	IIC master serial clock

9	I2C_DAT	GND
10	NC	VCC Input
11	CSPI_CLK	VCC Input
12	CSPI_MOSI	NC
13	CSPI_MISO	Backlight enable
14	TP_SPI_SCSn	Touch Pad Busy Signal
15	DISP0_DEN	Touch Pad Interruput
16	DISP0_HSYNC	IIC master serial clock
17	DISP0_VSYNC	IIC serial bidirectional data
18	DISP0_CLK	NC
19	GND	SPI serial clock
20	DISP0_DAT23	SPI Master Output, Slave Input
21	DISP0_DAT22	SPI Master Input, Slave Output
22	DISP0_DAT21	SPI Chip Select
23	DISP0_DAT20	Data enable (TFT)
24	GND	LCD Horizontal Synchronization
25	DISP0_DAT19	LCD Vertical Synchronization
26	DISP0_DAT18	DISP0_DAT18
27	DISP0_DAT17	DISP0_DAT17
28	DISP0_DAT16	DISP0_DAT16
29	GND	GND
30	DISP0_DAT15	DISP0_DAT15
31	DISP0_DAT14	DISP0_DAT14
32	DISP0_DAT13	DISP0_DAT13
33	DISP0_DAT12	DISP0_DAT12
34	GND	GND
35	DISP0_DAT11	DISP0_DAT11
36	DISP0_DAT10	DISP0_DAT10
37	DISP0_DAT9	DISP0_DAT9
38	DISP0_DAT8	DISP0_DAT8
39	GND	GND
40	DISP0_DAT7	DISP0_DAT7
41	DISP0_DAT6	DISP0_DAT6
42	DISP0_DAT5	DISP0_DAT5
43	DISP0_DAT4	DISP0_DAT4
44	GND	GND
45	DISP0_DAT3	DISP0_DAT3
46	DISP0_DAT2	DISP0_DAT2
47	DISP0_DAT1	DISP0_DAT1
48	DISP0_DAT0	DISP0_DAT0
49	GND	GND
50	ID_SYS	ID_SYS

Table 4 Pin Definitions of J13

Pins	Definitions	Descriptions
1	NC	NC
2	5VIN	VCC Input
3	GND	GND
4	GND	GND
5	DISP0_CLK	LCD Pixel Clock
6	DISP0_DAT3	DISP0_DAT3
7	DISP0_DEN	Data enable (TFT)
8	DISP0_DAT4	DISP0_DAT4
9	DISP0_HSYNC	Horizontal Synchronization
10	DISP0_DAT5	DISP0_DAT5
11	DISP0_VSYNC	Vertical Synchronization
12	DISP0_DAT6	DISP0_DAT6
13	DISP0_DAT7	DISP0_DAT7
14	DISP0_DAT23	DISP0_DAT23
15	DISP0_DAT15	DISP0_DAT15
16	NC	NC
17	DISP0_DAT19	DISP0_DAT19
18	NC	NC
19	DISP0_DAT20	DISP0_DAT20
20	TBD	TBD
21	DISP0_DAT21	DISP0_DAT21
22	TBD	TBD
23	DISP0_DAT22	DISP0_DAT22
24	TP_BUSY	Touch Pad Busy Signal
25	DISP0_DAT10	DISP0_DAT10
26	TP_INT	Touch Pad Interruput
27	DISP0_DAT11	DISP0_DAT11
28	CSPI_MOSI	SPI Master Output, Slave Input
29	DISP0_DAT12	DISP0_DAT12
30	CSPI_CLK	SPI Master Input, Slave Output
31	NC	NC
32	TP_SPI_SCSn	DISP0_DAT6
33	NC	NC
34	CSPI_MISO	DISP0_DAT5
35	I2C4_SCL	IIC master serial clock
36	DISP0_DAT13	DISP0_DAT13
37	I2C4_SDA	IIC serial bidirectional data
38	DISP0_DAT14	DISP0_DAT14
39	GND	GND
40	LCD_PWM	Backlight Enable

Table 5 SPI line module select

module	Application	Jumper cap select	The SPI module of SAMA5D3 Xplained (J22)
V 1	SAMA5D3 Xplained Version A	J11 PIN3------PIN2 J12 PIN3------PIN2 J14 PIN3------PIN2 J15 PIN3------PIN2	PIN 37 = SPI0_NPCS3 PIN 38 = SPI0_MISO PIN 39 = SPI0_MOSI PIN 40 = SPI0_SPCK
V 2	SAMA5D3 Xplained Version B	J11 PIN1------PIN2 J12 PIN1------PIN2 J14 PIN1------PIN2 J15 PIN1------PIN2	PIN 37 = SPI0_SPCK PIN 38 = SPI0_MOSI PIN 39 = SPI0_MISO PIN 40 = SPI0_NPCS3

Use of LCD-EX

Hereafter SAMA5D3 Xplained development board and a 4.3-inch LCD module will be taken as the example devices working with LCD-EX.

Note: If use a 7-inch LCD module, it is recommended to use USB power supply, do not use the computer USB power supply.

1. Configuring Kernel

1） Linux kernel includes lots of DTS files suited for different kinds of chips and platforms. Let's assuming a 4.3-inch LCD display is used and the configuration file should be selected accordingly. (LCDs of different sizes need different DTS files, but same configurations)

Table 6 configuration File for 4.3-inch LCD

```
cd linux-3.10.0
vim arch/arm/boot/dts/ at91-sama5d3_xplained_pda4.dts
ahb {
    apb {
        mmc0: mmc@f0000000 {
            pinctrl-names = "default";
            pinctrl-0 = <&pinctrl_mmc0_clk_cmd_dat0 &pinctrl_mmc0_dat1_3
 &pinctrl_mmc0_dat4_7 &pinctrl_mmc0_cd>;
            status = "okay";
            slot@0 {
                reg = <0>;
                bus-width = <8>;
                cd-gpios = <&pioE 0 GPIO_ACTIVE_LOW>;
            };
        };

        spi0: spi@f0004000 {
            cs-gpios = <&pioD 13 0>, <&pioD 16 0>, <0>, <0>;
            status = "okay";

            ads7846: touchscreen@0 {
                compatible = "ti,tsc2046";
                reg = <1>;
                spi-max-frequency = <1000000>;
                pinctrl-names = "default";
                pendown-gpio = <&pioE 7 0>;
                irq = <&pioE 7 0>;
                ti,settle-delay-usec = /bits/ 16 <150>;
                ti,debounce-max = /bits/ 16 <10>;
                ti,debounce-tol = /bits/ 16 <5>;
```

```
                ti,debounce-rep = /bits/ 16 <1>;
                ti,keep-vref-on = /bits/ 16 <1>;
                ti,x-min = /bits/ 16 <0>;
                ti,x-max = /bits/ 16 <8000>;
                ti,y-min = /bits/ 16 <0>;
                ti,y-max = /bits/ 16 <4800>;
                ti,x-plate-ohms = /bits/ 16 <40>;
                ti,pressure-max = /bits/ 16 <255>;
                linux,wakeup;
                status = "okay";
            };
        };

        can0: can@f000c000 {
            status = "okay";
        };
```

The IRQ register information of mxt needs to be removed when connecting resistive touch-screen, because the atmel_mxt_ts IRQ pin of the display would be used by module driver too.

Table 7 Remove IRQ Register Information

```
vim arch/arm/boot/dts/at91-sama5d3_xplained_dm_pda4.dtsi
ahb {
    apb {
        i2c1: i2c@f0018000 {
            qt1070: keyboard@1b {
                compatible = "qt1070";
                reg = <0x1b>;
                interrupt-parent = <&pioE>;
                interrupts = <8 0x0>;
                pinctrl-names = "default";
                pinctrl-0 = <&pinctrl_qt1070_irq>;
                wakeup-source;
            };

            atmel_mxt_ts@4a {
                compatible = "atmel,atmel_mxt_ts";
                reg = <0x4a>;
                /*
                interrupt-parent = <&pioE>;
                interrupts = <7 0x0>;
                pinctrl-names = "default";
```

```
                    pinctrl-0 = <&pinctrl_mxt_ts>;
                    */
                    status = "okay";
                };
            };
```

Configuring the kernel to include driver for TSC2045.

Table 8 Configuration of Driver

```
make ARCH=arm menuconfig
Device Drivers  --->
  Input device support  --->
    [*]   Touchscreens  --->
      <*>   ADS7846/TSC2046/AD7873 and AD(S)7843 based touchscreens
```

Note:

📖 The code marked in blue in these table are the parts that can be added or changed for realizing different configurations.

2） Execute the following instructions to recompiling the kernel;

- **make ARCH=arm CROSS_COMPILE=arm-none-linux-gnueabi- dtbs**
- **make ARCH=arm CROSS_COMPILE=arm-none-linux-gnueabi- uImage**

3） The image files generated can be found under the following directories;

DTB image: arch/arm/boot/dts/at91-sama5d3_xplained_pda4.dtb

uImage: arch/arm/boot/uImage

2. Connections and Tests

1） Use two flat ribbon cables with pins on same side to connect the conversion module, SAMA5D3 Xplained and LCD module together as shown below;

Figure 5 Hardware Connections

2） Connect the debugging serial interface of SAMA5D3 Xplained to PC and then power on the development board;

3） Update the system with new uImage and at91-sama5d3_xplained_pda4.dtb, and then reboot to enter Linux system;

4） Execute the following instruction to view the device node of touch-screen;

- root@sama5d3_xplained:~# **dmesg |grep -ir ads7846**

The terminal window shows information as follows;

Table 9 Device Node Information

ads7846 spi0.1: touchscreen, irq 52

```
input:  ADS7846  Touchscreen  as
/devices/ahb.0/apb.1/f0004000.spi/spi_master/spi0/spi0.1/input/input0
```

The characters above marked in blue represent the device node.

Note:

📖 input0 is associated to /dev/input/event0, input1 is associated to /dev/input/event1, and so on.

5） Execute the following instruction to set environment variable for tslib;

- root@sama5d3_xplained:~# **export TSLIB_TSDEVICE=/dev/input/event0**

6） Execute the following instruction to run a calibration on touch-screen;

- root@sama5d3_xplained:~# **ts_calibrate**

7） Execute the following instruction to test touch-screen;

- root@sama5d3_xplained:~# **ts_test**

Considerations

Please note the following considerations when connecting the hardware together:

1） If touch-screen is not precise as it should be after screen calibration, please check the connection between the module and flat ribbon cable to ensure that the 4 pins-for-touch of the interface on the module are correctly connected to the pins of touch-screen, in other words, ensure the X pin of the module (or touch-screen) is connected to the X pin of touch-screen (or the development board);

2） There are two 50-pin PFC interfaces on the module named J1 and J2 respectively. J1 is a flip-lock connector used to connect LCDs; J2 is a slide-lock connector used to connect controllers. LCD displays cannot work if being connected to the wrong interface;

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