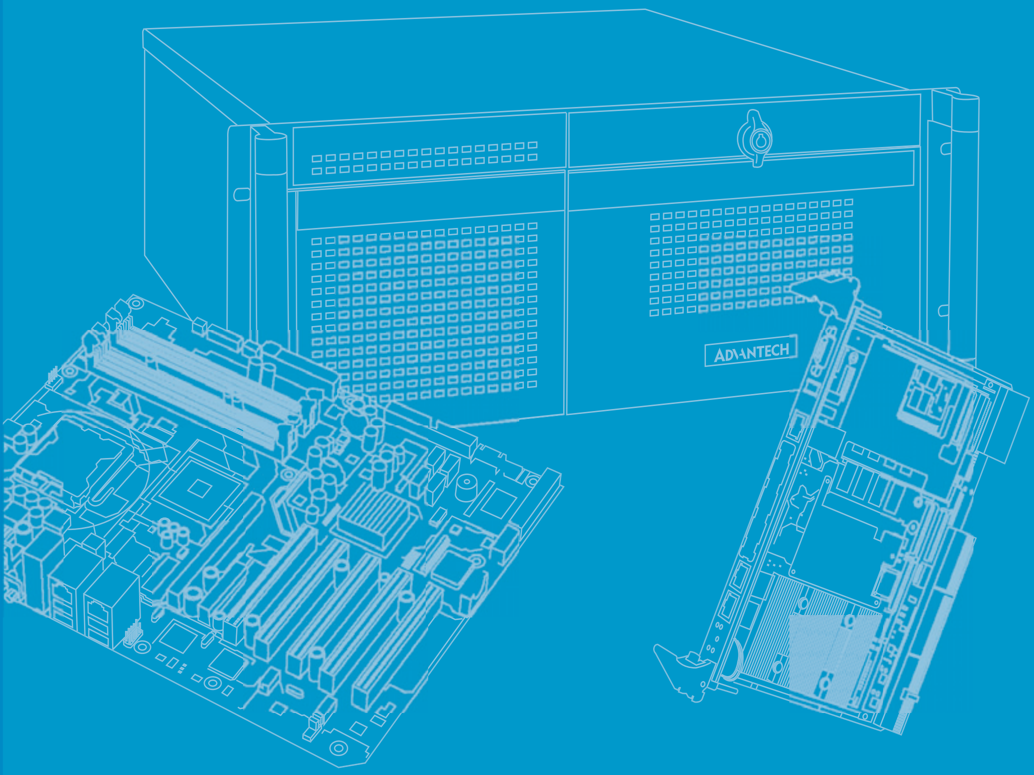

User Manual

RSB-4210 Evaluation Kit

Freescale i.MX53 Processor - ARM® Cortex™ A8 Architecture

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Acknowledgements

Product Warranty (2 years)

Advantech warrants to you, the original purchaser, that each of its products will be free from defects in materials and workmanship for two years from the date of purchase.

This warranty does not apply to any products which have been repaired or altered by persons other than repair personnel authorized by Advantech, or which have been subject to misuse, abuse, accident or improper installation. Advantech assumes no liability under the terms of this warranty as a consequence of such events.

Because of Advantech's high quality-control standards and rigorous testing, most of our customers never need to use our repair service. If an Advantech product is defective, it will be repaired or replaced at no charge during the warranty period. For out-of-warranty repairs, you will be billed according to the cost of replacement materials, service time and freight. Please consult your dealer for more details.

If you think you have a defective product, follow these steps:

1. Collect all the information about the problem encountered. (For example, CPU speed, Advantech products used, other hardware and software used, etc.) Note anything abnormal and list any onscreen messages you get when the problem occurs.
2. Call your dealer and describe the problem. Please have your manual, product, and any helpful information readily available.
3. If your product is diagnosed as defective, obtain an RMA (return merchandize authorization) number from your dealer. This allows us to process your return more quickly.
4. Carefully pack the defective product, a fully-completed Repair and Replacement Order Card and a photocopy proof of purchase date (such as your sales receipt) in a shippable container. A product returned without proof of the purchase date is not eligible for warranty service.
5. Write the RMA number visibly on the outside of the package and ship it prepaid to your dealer.

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Packing List

Before setting up the system, check that the items listed below are included and in good condition. If any item does not accord with the table, please contact your dealer immediately.

- RSB-4210 (P/N: RSB-4210CF-A78AAE)
- 7" LED PANEL 320N 4WR T/S 800X480(G), 97G070V1N0F-2, P/N: 96LEDK-A070WV32RB1)
- LCD Backlight Cable (P/N: 1700019577)
- LVDS Cable (P/N: 1700014418)
- Touch Cable (P/N: 1700000194)
- SQFlash SD Card SLC 2G, 2CH(-40 ~ 85° C) (P/N: SQF-ISDS2-2G-ETE)
- A CABLE SATA 15P/1*4P-2.5 35cm for AIMB-213 (P/N: 1700018785)
- M Cable SATA 7P/SATA 7P 8CM C=R 180/180 (P/N:1700004711)
- Mini USB Host Cable (P/N: 1700019076)
- Mini USB Client Cable (P/N: 1700019077)
- USB Type-A Cable (P/N: 1700019129)
- ADAPTER 100-240 V 65 W 19 V 3.42 A 9NA0651256 (P/N: 1757003734)
- A Cable 2*8P-2.0/SPEAKER*2+DC JACK*3 40CM(P/N: 1700019546-11)
- F Cable IDE#2 10P-2.0/D-SUB 9P(M) 25CM (P/N: 1700100250)
- Terminal connector 9P Female (P/N: 1654909900)
- DVD-ROM for RSB-4210 Evaluation Kit (P/N: 2062421011)
- RS-232 and RS-485 cable (P/N: 1700019474)
- RS-422 cable (P/N: 1700019476)

Power Cord (Optional)

- 3 pin Power Cord for USA standard (P/N: 1700001524)
- 3 pin Power Cord for Europe standard (P/N: 170203183C)
- 3 pin Power Cord for UK standard (P/N: 170203180A)

Charger Board & Battery (Optional)

- A cable 1*6P-2.5/1*6P-2.5 140 mm (P/N: 1700018394)
- A cable 2*4P-2.0/2*4P-2.0 90 mm (P/N: 1700018395)
- PCM-739 Battery charger Board (P/N: 969K073900E)
- Battery 11.1 V 6300 mAh 3S3P (P/N: 1760001300)

Safety Instructions

1. Read these safety instructions carefully.
2. Keep this User Manual for later reference.
3. Disconnect this equipment from any AC outlet before cleaning. Use a damp cloth. Do not use liquid or spray detergents for cleaning.
4. For plug-in equipment, the power outlet socket must be located near the equipment and must be easily accessible.
5. Keep this equipment away from humidity.
6. Put this equipment on a reliable surface during installation. Dropping it or letting it fall may cause damage.
7. The openings on the enclosure are for air convection. Protect the equipment from overheating. DO NOT COVER THE OPENINGS.
8. Make sure the voltage of the power source is correct before connecting the equipment to the power outlet.
9. Position the power cord so that people cannot step on it. Do not place anything over the power cord.
10. All cautions and warnings on the equipment should be noted.
11. If the equipment is not used for a long time, disconnect it from the power source to avoid damage by transient overvoltage.
12. Never pour any liquid into an opening. This may cause fire or electrical shock.
13. Never open the equipment. For safety reasons, the equipment should be opened only by qualified service personnel.
14. If one of the following situations arises, get the equipment checked by service personnel:
    - The power cord or plug is damaged.
    - Liquid has penetrated into the equipment.
    - The equipment has been exposed to moisture.
    - The equipment does not work well, or you cannot get it to work according to the user's manual.
    - The equipment has been dropped and damaged.
    - The equipment has obvious signs of breakage.

Contents

Chapter 1

Overview

This chapter briefly introduces the RSB-4210 Platform and RSB-4210 Evaluation Kit.

1.1 Introduction

In order to offer potential RISC-based Design-to-Order-Service (DTOS) project customers with a more efficient and low risk evaluation tool, Advantech provides a variety of RISC-based evaluation kits. Before DTOS projects kick-off, customers can check their designs with these kits in detail more easily. The evaluation kits are already equipped with all of the necessary H/W and S/W parts which customers will need, thus reducing design effort and speeding up application development.

The RSB-4210 is designed as a single board computer (SBC) solution, with a Freescale i.MX53 processor based on ARM® Cortex™ A8 architecture, which is a complete 32-bit, up to 1GHz speed SoC engine. It provides customers with a high performance board subsystem based on ARM® Cortex™ A8 which is ready-to-run, compact, and easy-to-expand in order to meet customers' versatile needs. With flexible I/O interfaces and complete hardware and software solutions, RSB-4210 is a fast time-to-market platform for customers to develop their applications and products easily without considering system integration.

The RSB-4210 Evaluation Kit is a complete system designed for customers to evaluate RSB-4210. It integrates all of the solutions that developers will need into a package for project evaluation, application development, and solution feasibility testing that decreases lead-time and lowers initial expense. All the functions included in the kit have been certified under Linux, ensuring that project development is more simple, less risky and easier to implement.

1.2 Features

RSB-4210 incorporates a Freescale i.MX53 Processor - ARM® Cortex™ A8 architecture as its SoC solution. The main features of this platform are a heatsink-less and compact design, and great reliability and power management making it suitable for the following applications:

- Economical HMI (Human Machine Interface)
- Self Service / Access Control
- Fleet management / Navigation
- Hand-held data collector

And the main features of Freescale i.MX53 processor are shown as follows:

- ARM® Cortex™-A8 1GHz high performance processor
- Supports OpenGL ES 2.0 and OpenVG® 1.1 hardware accelerators
- Supports full HD 1080p video decode and HD 720p video encode hardware engine Freescale Smart Speed® Technology support low power consumption
- I/O through 3.3 V I/O voltage and wide working temperature by industrial design concept
- Rich I/O for high expansion capability: UART(5), Dual LVDS, Audio, USB Host, USB OTG, Dual LAN, SD(2), SATA(1), GPIO(20), I2C(2), SPI(1), I2S(1), CAN(1), Keypad 6X6, Touch, Mini PCI-E and System Bus
- Supports SATA storage interface and CAN bus for vehicle application
- Supports Android2.3, Embedded Linux2.6 and Windows Embedded Compact 7
- Support wide working temperature -40 ~ 85° C operation temperature (optional)

1.3 Hardware Specifications

Item	Description
Kernel	
CPU	Freescale i.MX53 1GHz (ARM Cortex A8)
2D/3D Accelerators	Support OpenGL ES 2.0 and OpenVG™ 1.1 hardware accelerators
System RAM	512 MB (Optional: 256 MB)
Onboard Flash	2 GB (Optional: None)
RTC	Yes
Watchdog Timer	Yes
Reset	H/W reset & S/W reset
I/O	
COM	COM 1, RS-232, 2–wire(TX/RX), Pin header, (Debug port) COM 2, RS-232, D-Sub9 Connector(TX/RX/RTS/CTS) COM 3, RS-485, 2-pin Phoenix Connector COM 4, 3.3 V TTL, 4–wire(TX/RX/RTS/CTS), Pin header COM 5, RS-232, 4–wire(TX/RX/RTS/CTS), Pin header
Ethernet LAN	2 x 10/100 BASE-T (RJ-45)
USB Port	3 x USB 2.0 (High speed)
USB OTG	1 x USB 2.0 OTG (High speed)
SD/MMC	2 x SDIO/MMC interface (SD slot x 1+ pin header x 1)
Mini PCI-E	1 x (Controlled by USB interface only)
SIM Card slot	1
SATA	1
Touch Screen	1 x 4 - wire resistive type interface
System Bus	Yes (Address: 25 pins, data: 16 pins)
I^{2}C Interface	2
I^{2}S Interface	1
SPI Interface	1
CAN BUS	1
Hotkey/ Matrix keypad	Support 6 x 6 matrix keypad
GPIO	20 pins 3.3 V TTL level GPIOs
Buzzer control	Yes
Multimedia	
Graphic Chip	CPU internal LCD controller
LCD Resolution	Default: 800 x 480 7” WVGA Optional: 320 x 240 ~ 1920 x 1080
Dual LVDS	2 x 24-bit LVDS
HDMI	1 x (Co-lay with VGA)
VGA	1 x (Co-lay with HDMI)
Brightness/ Backlight Control	Yes
Audio	Line-in(Stereo),Line-out(Stereo),Speak-Out(Stereo)&Mic-in(Mono)
Power	
DC-input	9 ~ 24 V 5%
Battery Support	Yes (With external battery and charger board thru connector)

Power Consumption	Normal Run ~2.3 W Full Run ~3.8 W
Power Control	1 x Power ON/OFF Pin header 1 x H/W reset Pin header 1 x Suspend Pin header
Power Management	-Standard mode -Idle mode
Mechanical and Environmental	
Board size	146 x 102 x 20 mm (PCB thickness 1.6 mm; 8 layer)
Weight	110 g
Operation Tempera-ture	0 ~ 60° C (32 ~ 140° F) (-40 ~ 85° C by component change)
Operating Humidity	5% ~ 95% Relative Humidity, non condensing
Vibration	3.5 G, 1000 times
Others	
RoHS	Yes
Certification	CE/FCC Class A
O.S	Embedded Linux 2.6.35 (Default), Android 2.3.4, and Windows Embedded Compact 7

1.4 Board Block Diagram

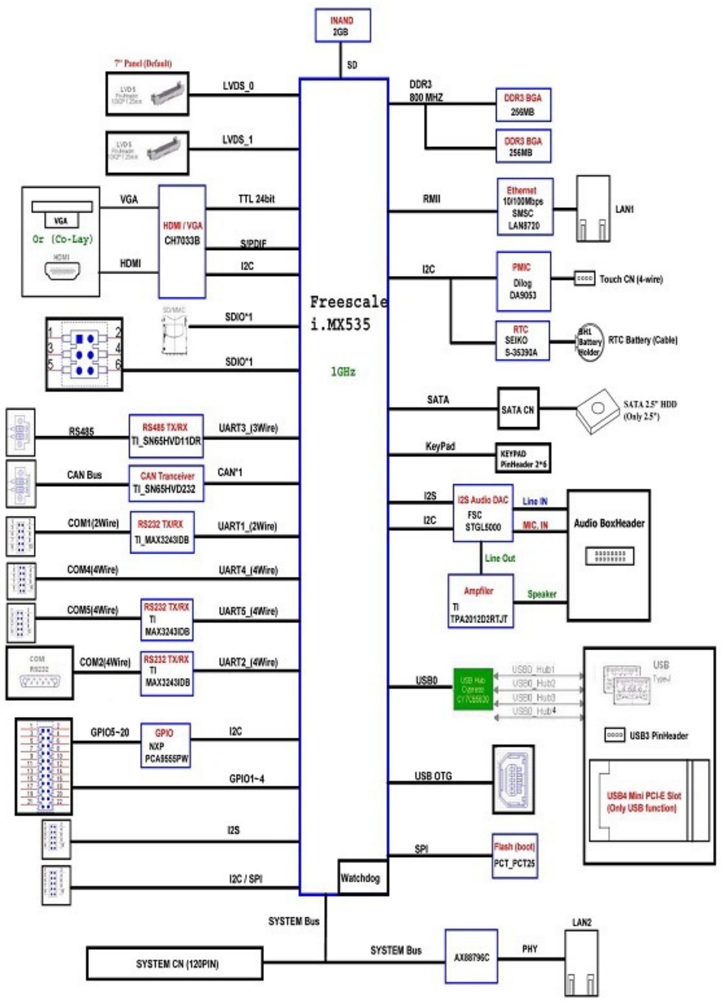


Figure 1.1 RSB-4210 Board Block Diagram

Chapter 2

H/W Installation

This chapter introduces the setup procedures of the RSB-4210 hardware, including instructions on setting jumpers and connecting peripherals, switches, indicators and mechanical drawings.

Be sure to read all safety precautions before you begin this installation procedure.

2.1 Development Kit H/W Installation

The Figure 2-1 is RSB-4210 Evaluation Kit Assembly, and the detail descriptions with Advantech P/N are shown as below.

Item	Description	Advantech P/N
Part-A	RSB-4210	(P/N: RSB-4210CF-A78AAE)
Part-B1	7” LCD-LED Backlight, LVDS, 800x480, T/S, 97G070V1N0F-2	(P/N: 96LEDK-A070WV32RB1)
Part-B2	LCD Backlight Cable	(P/N: 1700019577)
Part-B3	LVDS Cable	(P/N: 1700014418)
Part-B4	Touch Cable	(P/N: 1700000194)
Part-C	SQFlash SD Card, SLC 2GB, (-40~85°C)	(P/N: SQF-ISDS2-2G-ETE)
Part-D	SATA Power Cable	(P/N: 1700018785)
Part-E	SATA Cable	(P/N: 1700004711)
Part-F	Mini USB Host Cable	(P/N: 1700019076)
Part-G	Mini USB Client Cable	(P/N: 1700019077)
Part-H	USB Type-A Cable	(P/N: 1700019129)
Part-I	Mini Jumper	(P/N:1653302122)
Part-J	Null modem cable	(P/N: 1700091002)
Part-K	ADAPTER, 100-240V, 19V, 3.42A.	(P/N: 1757003734)
Part-L	3 pin Power Cord (USA Standard) [Optional] 3 pin Power Cord (Europe standard) [Optional] 3 pin Power Cord (UK standard) [Optional]	(P/N: 1700001524) (P/N: 170203183C) (P/N: 170203180A)
Part-M	Speaker & Audio Cables	(P/N: 1700019546-11)
Part-N1	Power Cable for Charger Board [Optional]	(P/N: 1700018394)
Part-N2	Signal Cable for Charger Board [Optional]	(P/N: 1700018395)
Part-N3	Charger Board [Optional]	(P/N: 969K073900E)
Part-N4	Battery [Optional]	(P/N: 1760001300)
Part-O1	8*8 Keypad Cable [Optional]	(P/N: 1703200180)
Part-O2	8*8 Keypad [Optional]	(P/N: 96969315A0E)
Part-P	Suspend/Reset button cable [Optional]	(P/N:1700003414)
Part-Q	COM Port Cable	(P/N: 1700100250)
Part-R	RS-232 Loopback	(P/N: 1654909900)
Part-S	Terminal Block for CAN/RS-485	(P/N: 1652002209)

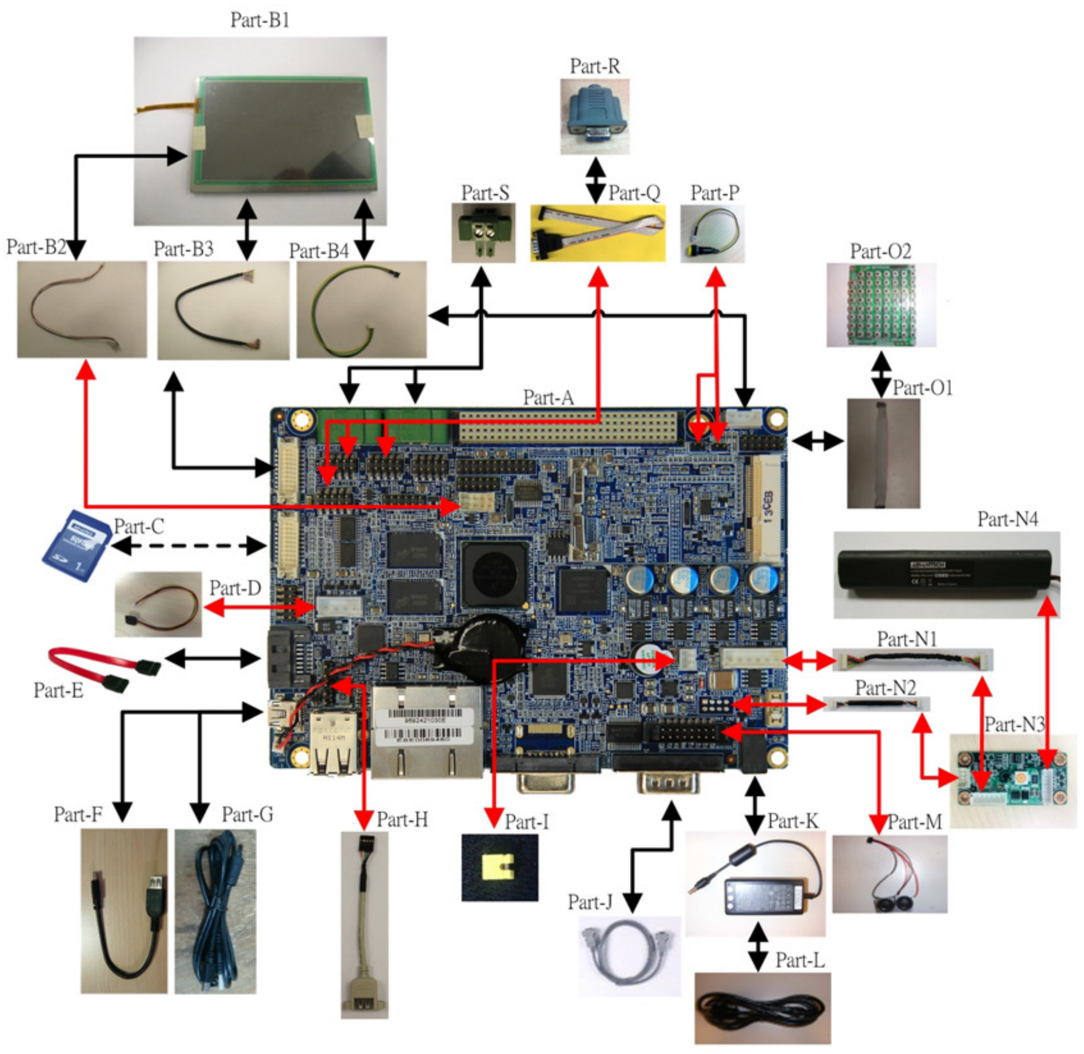


Figure 2.1 RSB-4210 Development Kit Assembly

2.1.1 RSB-4210 (Part-A)

RSB-4210 is a cost-effective, low-power, and high-performance SBC (Single Board Computer) without a heatsink, geared to satisfy the needs of industrial computing applications. Based on the Freescale i.MX53 Processor - ARM® Cortex™ A8 architecture, RSB-4210 comes with DDR3, and iNAND flash. RSB-4210 offers convenient connector layout, simple assembly, multiple common I/Os, and includes dual 10/100Mbps Ethernet, three USB (Universal Serial Bus) 2.0 connectors and five serial ports for easy system expansibility.

2.1.2 7" LVDS LCD Module (Part-B1)

The 7.0 inch Color TFT-LCD Module uses a 4-wire resistive type touch sensor. The module is designed with a wide viewing angle; wide operating temperature and long life LED backlight which is well suited for Industrial Applications. An LED driving board for backlight unit is included in this panel and the structure of the LED units is replaceable. It also has a built in timing controller and LVDS interface. The display supports the WVGA (800 (H) x 480(V)) screen format and 16.2 M colors (RGB 24bits) or 262 K (RGB 18 bits) selectable.

2.1.3 LCD Backlight Cable (Part-B2)

The LVDS backlight cable connects RSB-4210 (CN11) with the LCD backlight connector of 7" LVDS LCD Module.

2.1.4 LVDS Cable (Part-B3)

The LVDS cable connects RSB-4210 LVDS0 connector (CN8) with the LCD signal connector of 7" LVDS LCD Module.

2.1.5 Touch Cable (Part-B4)

The touch cable connects RSB-4210 (CN1) with the touch connector of 7" LVDS LCD Module.

2.1.6 SQFlash SD Card (Part-C)

The SQFlash SD card is a standard SD device. It is the flash-based solid-state drive available and uses SLC NAND flash memory, making it ideal as an embedded SSD solution. It connects on SD1 of RSB-4210.

2.1.7 SATA Power Cable (Part-D)

The SATA power cable provides the power signal for SATA HDD by connecting RSB-4210 (CN16) and the SATA HDD.

2.1.8 SATA Cable (Part-E)

The SATA cable provides the control signal with SATA HDD by connecting RSB-4210 (SATA_CN1) with the SATA HDD.

2.1.9 Mini USB Host Cable (Part-F)

The mini USB Host cable connects RSB-4210 (USB_OTG1) with one USB client device. For example, USB mouse/keyboard.

2.1.10 Mini USB Client Cable (Part-G)

The mini USB Client cable connects RSB-4210 (USB_OTG1) with PC or NB.

2.1.11 USB Type-A Cable (Part-H)

The USB extend cable provide Type-A for USB device. For example, USB mouse/keyboard.

2.1.12 Jumper (Part-I)

When plug-in the adapter with the wafer (CN17) shorted by this jumper, the system will power-on.

2.1.13 Null modem cable (Part-J)

The null modem cable connects RSB-4210 COM ports with a serial device.

2.1.14 19 V Power Adapter (Part-K)

The AC-to-DC power device provides a 19 V DC output (65 W max) with constant voltage sources (100 V ~ 240 V).

2.1.15 Power Cord (Part-L)

3P Power Cord (USA, Europe or UK standard) for 19 V Power Adapter AC input.

2.1.16 Speaker & Audio Cables (Part-M)

The cable connects with RSB-4210 (AUDIO1) and LINE-OUT, LINE-IN, MIC-IN and L&R Speakers.

2.1.17 Power Cable for Charger Board (Part-N1)

The cable provides the power for charger board. It connects RSB-4210 (BAT_CN1) with the charger board (CN2).

2.1.18 Signal Cable for Charger Board (Part-N2)

The cable provides the control signal for charger board. It connects RSB-4210 (BAT_CN2) with the charger board (CN1).

2.1.19 Charger Board (Part-N3)

The charger board provides 12v power to charge the battery when plug-in a 19v adapter, and RSB-4210 can read the battery status through this charger board.

Note! *It is necessary to use 19v adapter for charger board rather than 12v.*

2.1.20 Battery (Part-N4)

The battery can provide the power with RSB-4210 without any adapter.

2.1.21 Keypad Cable (Part-O1)

The keypad cable connects RSB-4210 (KEYPAD1) with the keypad.

2.1.22 Keypad (Part-O2)

8*8 arrays of 64 normally open single-pole switches. (6*6 region of keypad are available when using RSB-4210.)

2.1.23 Cable for Suspend/Reset Button (Part-P)

The cable is used to extend the Suspend/Reset function by a specific button.

2.1.24 COM Port Cable (D-SUB 9P to Housing) (Part-Q)

The cable is used to extend COM port 9pin header from RSB-4210 to D-SUB 9P serial port connector.

2.1.25 RS-232 Loopback (Part-R)

The terminal connector 9P female is used to test RS-232 loopback function.

2.1.26 Terminal Block for CAN/RS-485 (Part-S)

The terminal block can be extended with extra two cables to connect RSB-4210 CAN/RS-485 function with the others CAN/RS-485 devices.

2.2 RSB-4210 Connectors

The following table shows the connector list of RSB-4210.

Connector	Description
CN 1	Wafer for 4-wire Resistive Type Touch Screen
CN 2	Phoenix Connector for CAN Bus
CN 3	Phoenix Connector for COM3, RS-485
CN 4	System Bus
CN 5	Pin Header for COM5, RS-232 (TX/RX/RTS/CTS)
CN 6	Pin Header for COM4, 3.3V TTL (TX/RX/RTS/CTS)
CN 7	Pin Header for I2S
CN 8	LVDS0 LCD Connector
CN 9	Pin Header for COM1, RS-232 (TX/RX)
CN 10	Pin Header for SD2
CN 11	Wafer for Backlight Power and Controller
CN 12	MiniPCIe Connector-Latch
CN 13	MiniPCIe Connector
CN 14	LVDS1 LCD Connector
CN 15	Pin Header for Jtag
CN 16	Wafer for SATA Power
CN 17	Wafer for Power ON/OFF
CN 18	Ethernet LAN1&2 Connector
CN 19	Wafer for Coin Battery
CN 20	SIM Card Slot
RST_BTN1	Pin Header for Reset
SUS_BTN1	Pin Header for Suspend
KEYPAD1	Pin Header for Matrix Keypad
CN21	Pin Header for I2C/SPI
GPIO1	Pin Header for 20x pins GPIO
SATA_CN1	SATA Connector
USB1	Pin Header for USB_HUB1
BAT_CN1	Wafer for Battery Charger Board – Power
BAT_CN2	Wafer for Battery Charger Board – Control Signal
USB_OTG1	USB OTG MINI-AB Connector
USB2	USB_HUB_2&3 (Standard Type-A)
CRT1	VGA Connector
HDMI_CN1	HDMI Connector
AUDIO1	Box Header for LINE-OUT, LINE-IN, MIC-IN and L&R Speakers
COM1	D-Sub9 Connector for COM2, RS-232 (TX/RX/RTS/CTS)
DCIN1	DC-IN Power Jack
SD1	SD Card Slot

2.2.1 Wafer for 4-wire Resistive Type Touch Screen (CN1)

The touch screen interface performs all sampling, averaging, ADC range checking, and control for a wide variety of analog resistive touch screens. This controller only interrupts the processor when a meaningful change occurs.

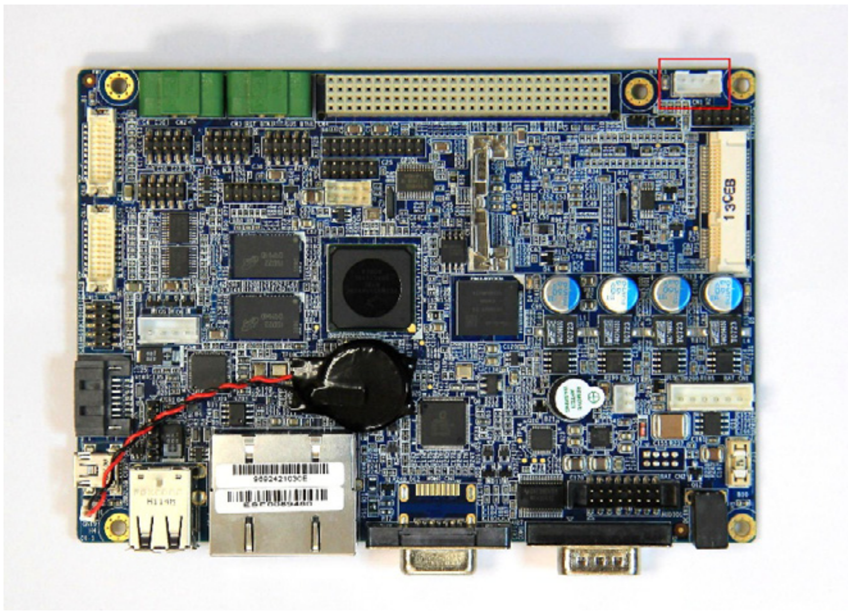


Figure 2.2 Wafer for 4-wire Resistive Type Touch Screen

Pin	Description	Pin	Description
1	Touch_Y-	2	Touch_Y+
3	Touch_X-	4	Touch_X+

2.2.2 Phoenix Connector for CAN Bus (CN2)

RSB-4210 supports one CAN bus, while CN2 is a phoenix connector for CAN bus.

Note! *For CAN applications, the two ends of the cable will have a termination resistor connected across the two wires. Without termination resistors, reflections of fast driver edges can cause multiple data edges that can cause data corruption. Please refer to Figure 2.4 and Figure 2.5 to adding a termination resistor (120 ohms) on your end device (R271 of RSB-4210, default is none) to avoid this situation.*

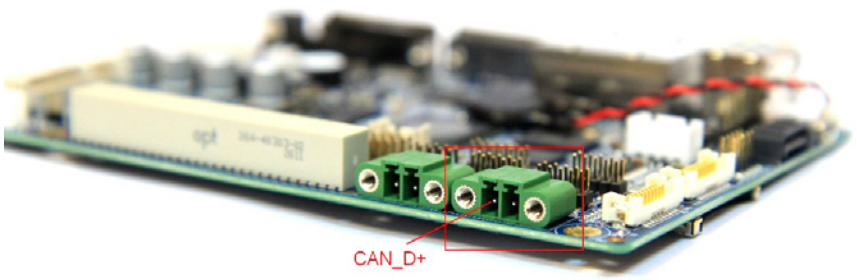


Figure 2.3 Phoenix Connector for CAN Bus

Pin	Description	Pin	Description
1	CAN_D+	2	CAN_D-

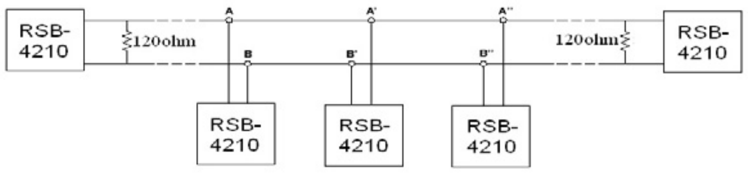


Figure 2.4 CAN Application

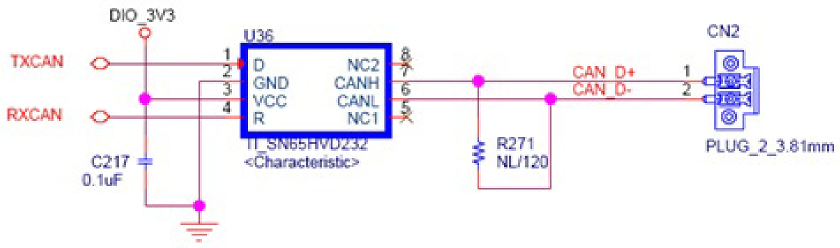


Figure 2.5 Schematics of CAN on RSB-4210

2.2.3 Phoenix Connector for COM3, RS-485 (CN3)

RSB-4210 supports one RS-485 interface, while CN3 is a phoenix connector for RS-485.

Note! *For RS-485 applications, the two ends of the cable will have a termination resistor connected across the two wires. Without termination resistors, reflections of fast driver edges can cause multiple data edges that can cause data corruption. Please refer to Figure 2.7 and Figure 2.8 to adding a termination resistor (120 ohms) on your end device (R289 of RSB-4210, default is 120 ohms) to avoid this situation.*

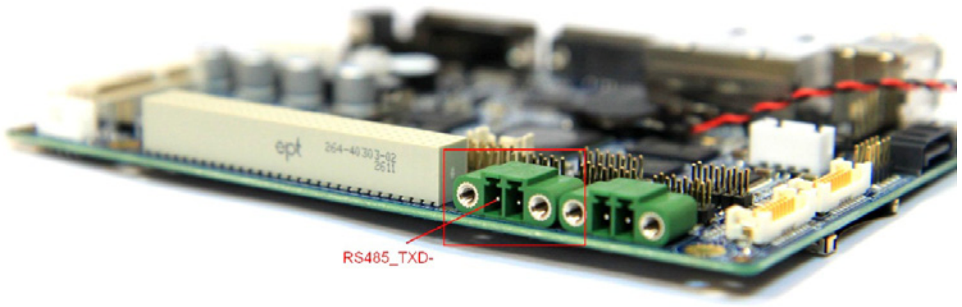


Figure 2.6 Phoenix Connector for COM3, RS-485

Pin	Description	Pin	Description
1	RS485_TXD-	2	RS485_TXD+

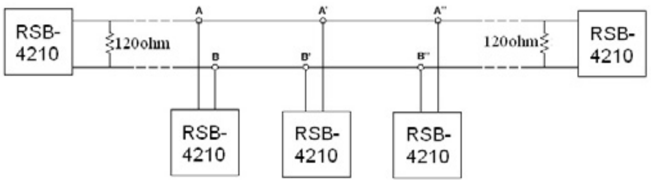


Figure 2.7 RS-485 Application

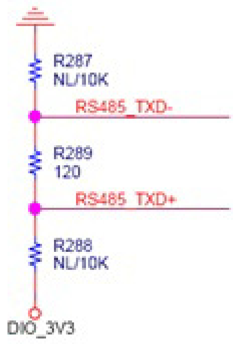


Figure 2.8 Schematics of RS-485 on RSB-4210

2.2.4 System Bus (CN4)

The RSB-4210 provides system bus via PCI104+ connector for extended device use. The pin assignments are shown below in Fig 2.9.

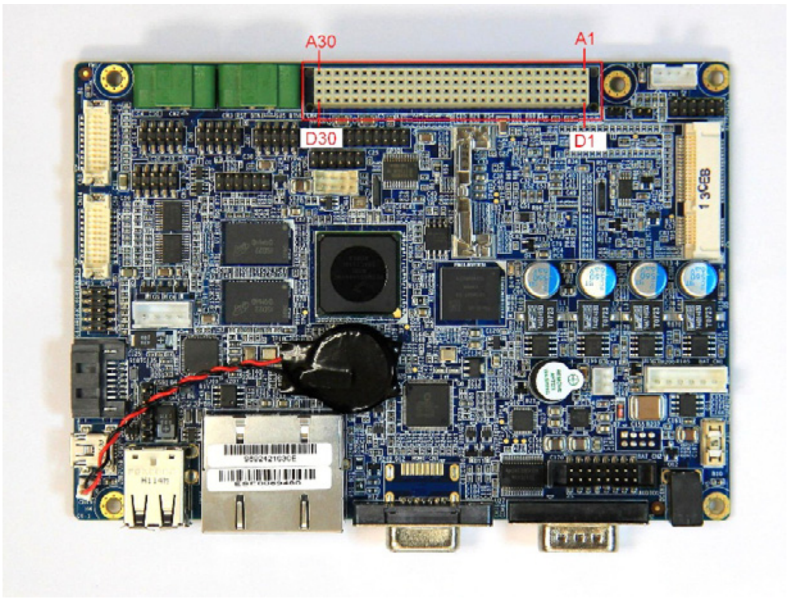


Figure 2.9 System Bus

Pin	Description	Pin	Description	Pin	Description	Pin	Description
A1	N/C	B1	GND	C1	N/C	D1	N/C
A2	GND	B2	N/C	C2	DIO_3V3	D2	DIO_3V3
A3	EX_GPIO_8	B3	IMX_GPIO4	C3	IMX_GPIO3	D3	IMX_GPIO2
A4	N/C	B4	N/C	C4	DIO_3V3	D4	DIO_3V3
A5	SysBus_A0	B5	SysBus_A1	C5	SysBus_A15	D5	SysBus_A14
A6	SysBus_A2	B6	SysBus_A3	C6	SysBus_A13	D6	SysBus_A12

A7	SysBus_A4	B7	SysBus_A5	C7	SysBus_A11	D7	SysBus_A10
A8	SysBus_A6	B8	SysBus_A7	C8	SysBus_A9	D8	SysBus_A8
A9	SysBus_A16	B9	SysBus_A17	C9	SysBus_A24	D9	N/C
A10	SysBus_A18	B10	SysBus_A19	C10	N/C	D10	SysBus_OE
A11	SysBus_A20	B11	SysBus_A21	C11	SysBus_RW	D11	GND
A12	SysBus_A22	B12	SysBus_A23	C12	N/C	D12	N/C
A13	DIO_3V3	B13	N/C	C13	SysBus_CS0	D13	SysBus_CS1
A14	SysBus_D0	B14	SysBus_D1	C14	SysBus_D15	D14	SysBus_D14
A15	SysBus_D2	B15	SysBus_D3	C15	SysBus_D13	D15	SysBus_D12
A16	SysBus_D4	B16	SysBus_D5	C16	SysBus_D11	D16	SysBus_D10
A17	SysBus_D6	B17	SysBus_D7	C17	SysBus_D9	D17	SysBus_D8
A18	N/C	B18	N/C	C18	N/C	D18	N/C
A19	N/C	B19	N/C	C19	N/C	D19	N/C
A20	N/C	B20	N/C	C20	N/C	D20	N/C
A21	N/C	B21	N/C	C21	N/C	D21	N/C
A22	N/C	B22	N/C	C22	SysBus_BCLK	D22	GND
A23	N/C	B23	N/C	C23	N/C	D23	GND
A24	N/C	B24	N/C	C24	SysBus_EB1	D24	DIO_3V3
A25	N/C	B25	N/C	C25	N/C	D25	DIO_3V3
A26	SysBus_nEB0	B26	N/C	C26	N/C	D26	N/C
A27	N/C	B27	SysBus_LBA	C27	5 V_EXT	D27	5V_EXT
A28	SysBus_WP	B28	N/C	C28	SysBus_Wait	D28	N/C
A29	N/C	B29	N/C	C29	N/C	D29	N/C
A30	SysBus_Wait	B30	N/C	C30	GND	D30	N/C

2.2.5 Pin Header for COM5, RS-232 (TX/RX/RTS/CTS) (CN5)

CN5 is a 4-wire (TX/RX/RTS/CTS) RS-232 port which provides connections between serial devices (For example, GPS, GSM and Bluetooth devices etc.) or a communication network.

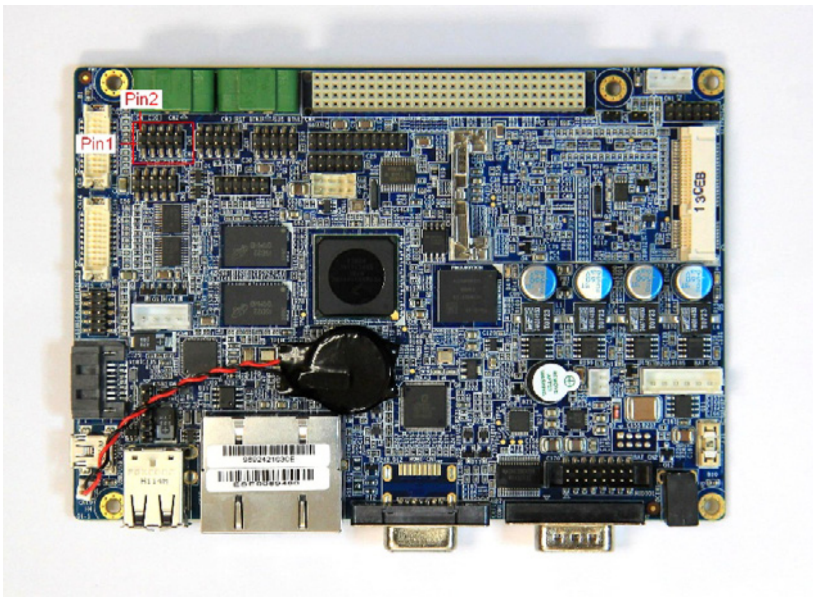


Figure 2.10 Pin Header for COM5, RS-232 (TX/RX/RTS/CTS)

Pin	Description	Pin	Description
1	N/C	2	N/C
3	COM5_RXD	4	COM5_RTS
5	COM5_TXD	6	COM5_CTS
7	N/C	8	N/C
9	GND	10	N/C

2.2.6 Pin Header for COM4, 3.3V TTL (TX/RX/RTS/CTS) (CN6)

CN6 is a 4-wire (TX/RX/RTS/CTS) 3.3 V TTL signal which provides connections between serial devices (For example, GPS, GSM and Bluetooth devices etc.) or a communication network.

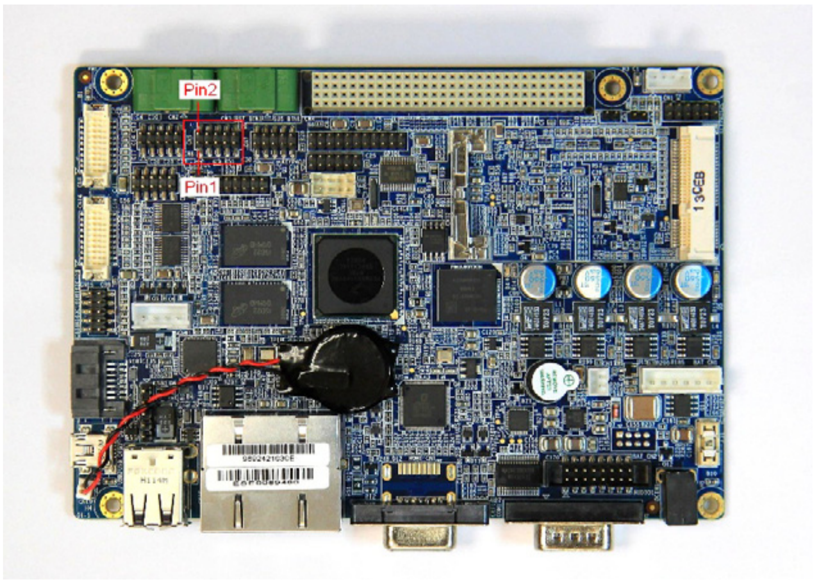


Figure 2.11 Pin Header for COM4, 3.3V TTL (TX/RX/RTS/CTS)

2.2.7 Pin Header for I2S (CN7)

RSB-4210 provides one I2S interface for users to expand their applications, and CN7 is the pin header for the I2S interface.

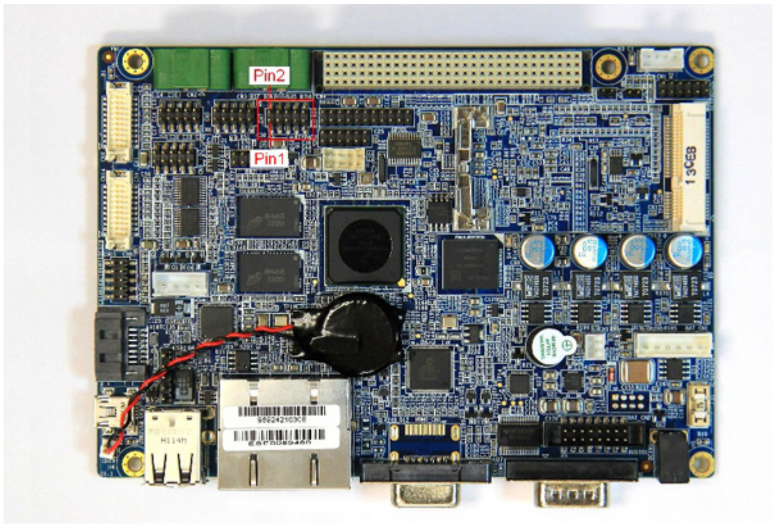


Figure 2.12 Pin Header for I2S

Pin	Description	Pin	Description
1	AUDIO_CLK	2	AUD3_TXD
3	AUD3_TXC	4	N/C
5	AUD3_TXFS	6	N/C
7	AUD3_RXD	8	N/C
9	GND	10	DIO_3V3

2.2.8 LVDS0 LCD Connector (CN8)

RSB-4210 supports dual LVDS LCD Interfaces (24+24 bit), in which CN8 is LVDS0 (24-bit) while CN14 is LVDS1 (24-bit). The pin assignment of LVDS0 (CN8) is shown as below.

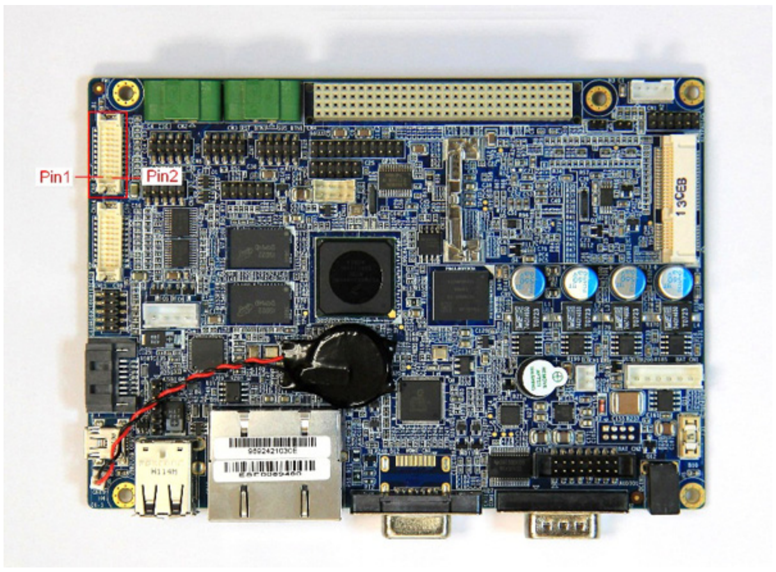


Figure 2.13 LVDS0 LCD Connector

Pin	Description	Pin	Description
1	3.3 V	2	3.3 V
3	3.3 V	4	3.3 V
5	LVDS0_TX0-	6	LVDS0_TX0+
7	GND	8	LVDS0_TX1-
9	LVDS0_TX1+	10	GND
11	LVDS0_TX2-	12	LVDS0_TX2+
13	GND	14	LVDS0_CLK-
15	LVDS0_CLK+	16	GND
17	3.3 V	18	N/C
19	LVDS0_TX3-	20	LVDS0_TX3+

2.2.9 Pin Header for COM1, RS-232 (TX/RX) (CN9)

CN9 is a 2-wire (TX/RX) RS-232 port which provides connections between serial devices (For example, GPS, GSM and Bluetooth devices etc.) or a communication network.

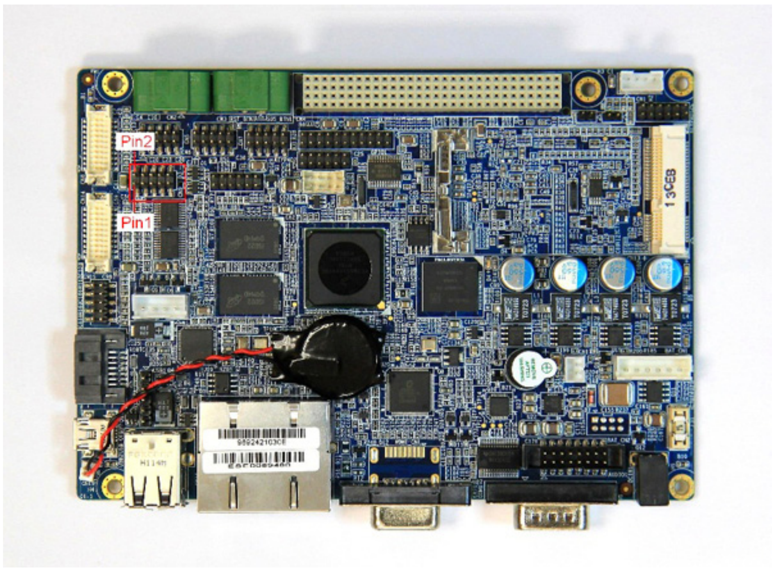


Figure 2.14 Pin Header for COM1, RS-232 (TX/RX)

Pin	Description	Pin	Description
1	N/C	2	N/C
3	COM1_RXD	4	N/C
5	COM1_TXD	6	N/C
7	N/C	8	N/C
9	GND	10	N/C

2.2.10 Pin Header for SD2 (CN10)

The SD/MMC Slots are 3.3 V powered, which are able to be extended for SD slot module and SDIO interface module with the following features:

- Fully compatible with the MMC system specification version 3.2
- Compatible with the SD Memory Card specification 1.01, and SD I/O specification 1.1 with 1/4 channel(s)
- Block-based data transfer between MMC card and SDHC (stream mode not supported)
- 100 Mbps maximum data rate in 4-bit mode, SD bus clock up to 25MHz

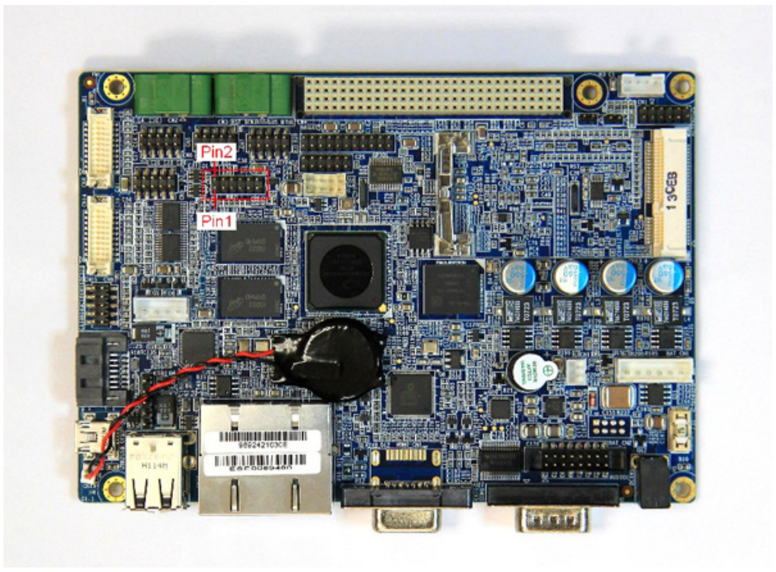


Figure 2.15 Pin Header for SD2

Pin	Description	Pin	Description
1	GND	2	GND
3	SD4_DATA1	4	SD4_CLK
5	SD4_DATA0	6	SD4_CMD
7	SD4_DATA3	8	SD4_CD
9	SD4_DATA2	10	3V3
11	N/C	12	N/C

2.2.11 Wafer for Backlight Power and Controller (CN11)

This wafer provides DC +12 V, DC +5 V, back-light on/off control signal and 0 ~ 5 V PWM dimming control to inverter. We suggest users choose an inverter so that dimming control is by PWM to fit development kit design.

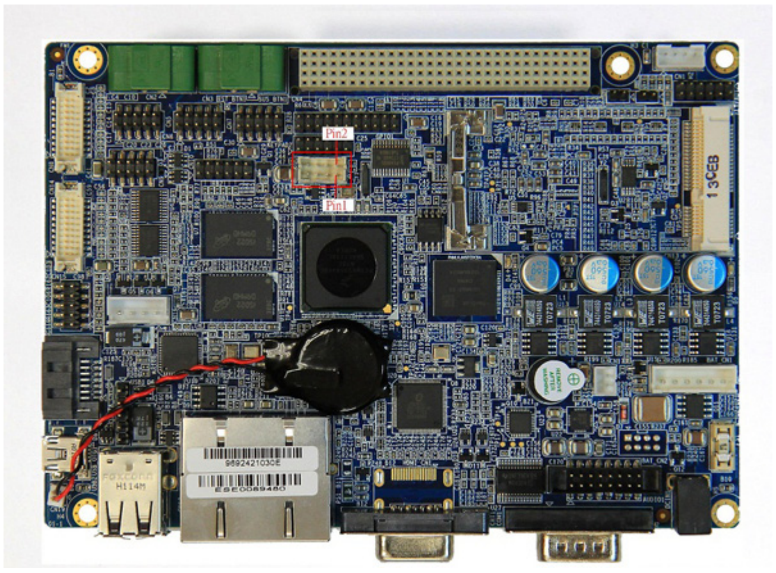


Figure 2.16 Wafer for Backlight Power and Controller

Pin	Description	Pin	Description
1	GND	2	GND
3	BLK_PWR_EN	4	BLK_PWR_EN
5	Brightness	6	PWM1
7	12 V	8	5 V

2.2.12 MiniPCIe Connector-Latch (CN12) and Connector (CN13)

RSB-4210 supports a MiniPCIe Interface. The pin assignment is shown below.

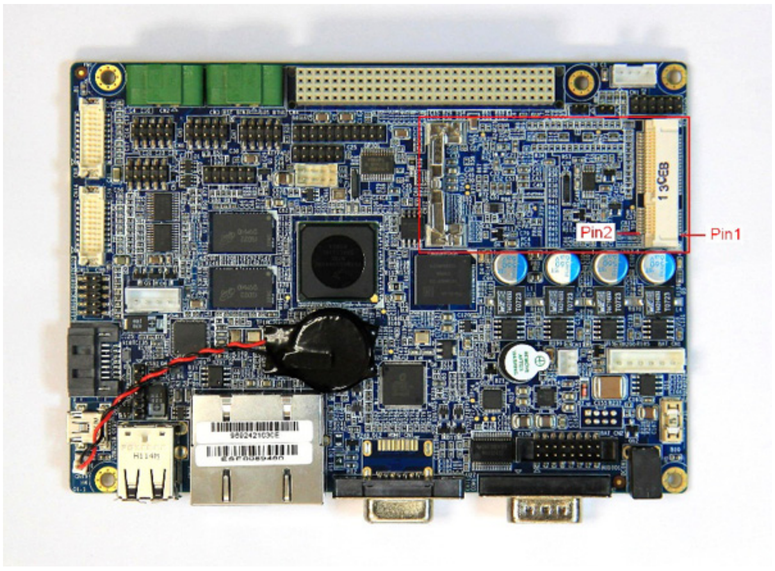


Figure 2.17 MiniPCIe Connector-Latch (CN12) and Connector (CN13)

Pin	Description	Pin	Description
1	nWAKE	2	DIO_3V3
3	N/C	4	N/C
5	N/C	6	IO_1V5
7	nCLKREQ	8	UIM_PWR
9	GND	10	UIM_DATA
11	PCIe_CLK_N	12	UIM_CLK
13	PCIe_CLK_P	14	UIM_RESET
15	GND	16	UIM_VPP
17	N/C	18	GND
19	N/C	20	N/C
21	GND	22	nRESET_OUT
23	PCIe_RX0_N	24	DIO_3V3
25	PCIe_RX0_P	26	GND
27	GND	28	IO_1V5
29	GND	30	PCIe_SMBCLK
31	PCIe_TX0_N	32	PCIe_SMBDAT
33	PCIe_TX0_P	34	GND
35	GND	36	USB_HUB4_D-
37	GND	38	USB_HUB4_D+

39	N/C	40	GND
41	N/C	42	LED_WWAN
43	GND	44	LED_WLAN
45	N/C	46	LED_WPAN
47	N/C	48	IO_1V5
49	N/C	50	GND
51	N/C	52	DIO_3V3
53	N/C	54	N/C
55	GND	56	GND

2.2.13 LVDS1 LCD Connector (CN14)

RSB-4210 supports dual LVDS LCD Interfaces (24+24bit), in which CN8 is LVDS0 (24 bit) while CN14 is LVDS1 (24 bit). The pin assignment of LVDS1 (CN14) is shown below.

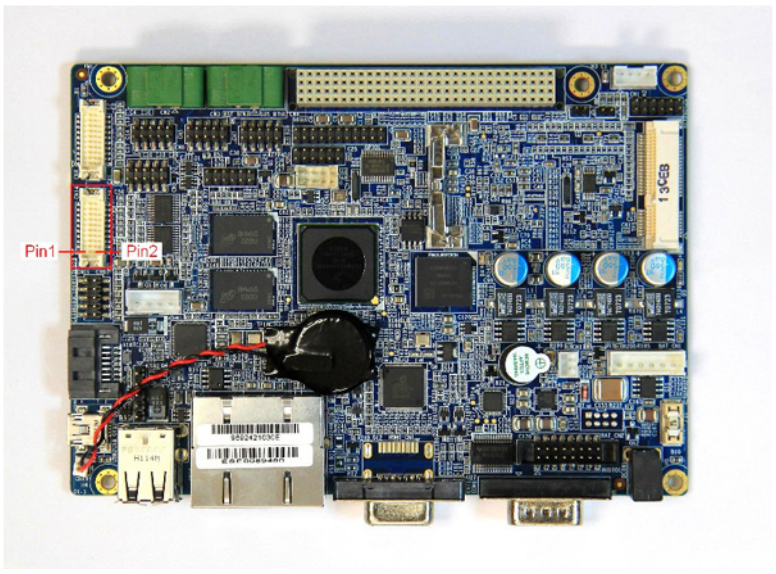


Figure 2.18 LVDS1 LCD Connector

Pin	Description	Pin	Description
1	5 V	2	5 V
3	5 V	4	5 V
5	LVDS1_TX0-	6	LVDS1_TX0+
7	GND	8	LVDS1_TX1-
9	LVDS1_TX1+	10	GND
11	LVDS1_TX2-	12	LVDS1_TX2+
13	GND	14	LVDS1_CLK-
15	LVDS1_CLK+	16	GND
17	N/C	18	N/C
19	LVDS1_TX3-	20	LVDS1_TX3+

2.2.14 Pin Header for Jtag (CN15)

RSB-4210 provides one Jtag interface for debugging CPU. CN15 is the pin header for Jtag interface.

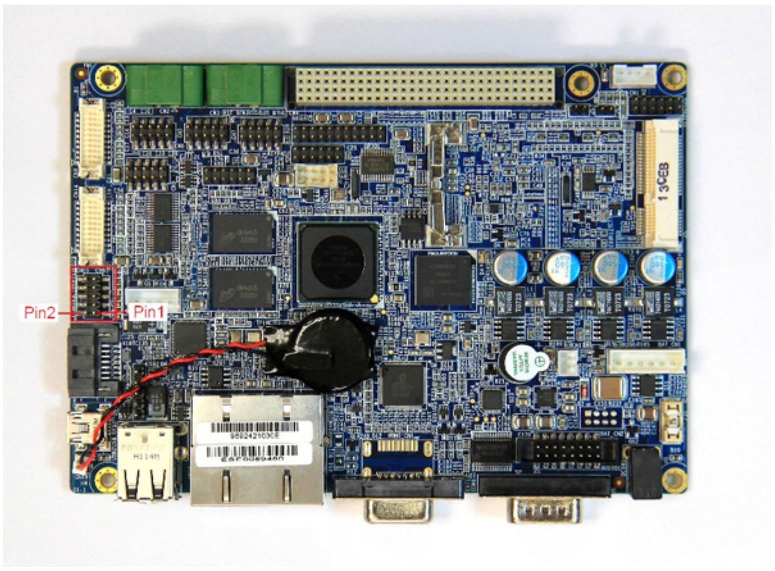


Figure 2.19 Pin Header for Jtag

Pin	Description	Pin	Description
1	JTAG_TCK	2	GND
3	JTAG_TMS	4	GND
5	JTAG_TDO	6	GND
7	JTAG_TDI	8	IO_3V3
9	JTAG_TRST	10	N/C

2.2.15 Wafer for SATA power (CN16)

CN16 provides DC +5 V for SATA device. The pin assignment is shown as below.

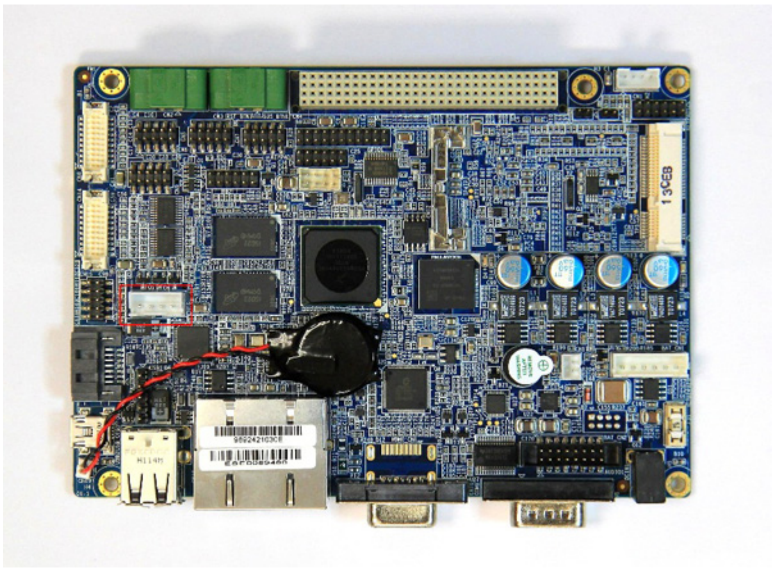


Figure 2.20 Wafer for SATA power

Pin	Description	Pin	Description
1	SATA_5 V	2	GND
3	GND	4	N/C

2.2.16 Wafer for Power ON/OFF (CN17)

When plug-in the adapter with CN17 shorted by a jumper, the system will power-on. Or you can connect this wafer with an external button to control the power ON/OFF.

Note! *If your system cannot power-on with an adapter, please check this wafer in advance. There should be a jumper or external power switch on the wafer.*

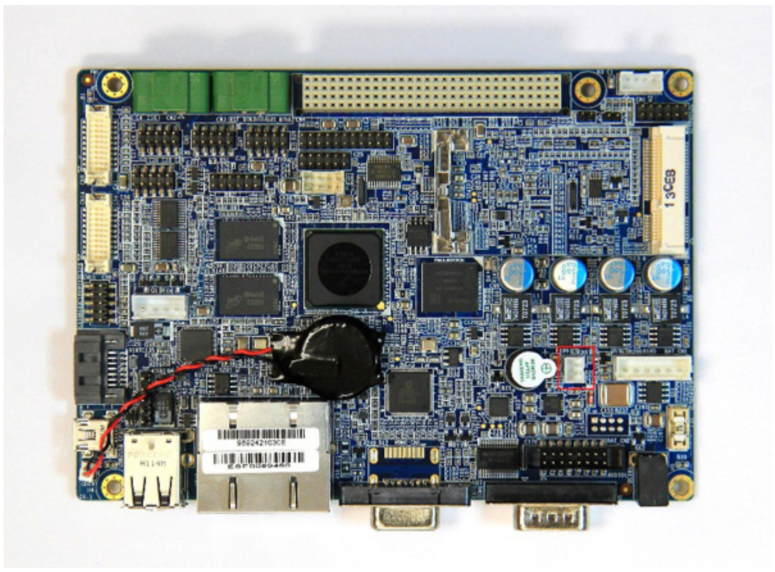


Figure 2.21 Pin Header for Power Button

Pin	Description	Pin	Description
1	PWR_BTN+	2	PWR_BTN-

2.2.17 Ethernet LAN1&2 Connector (CN18)

RSB-4210 supports dual LAN. One is extended from CPU module board directly and another is extended from system bus. Both of them support 10/100 Mbps transfer rates and are compliant with IEEE 802.3.

Note! *LAN connector with LED indicator: green LED indicates Ethernet active, while yellow LED indicates Ethernet speed 10/100.*

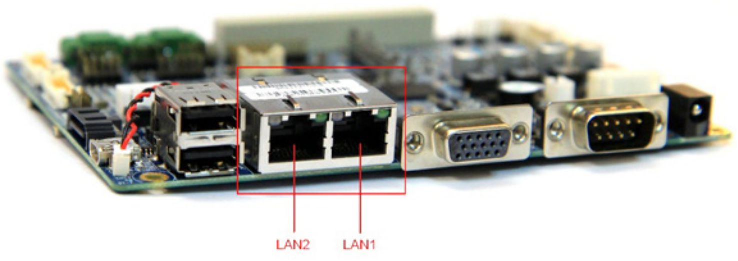


Figure 2.22 Ethernet LAN1 & LAN2 Connector

2.2.18 Wafer for Coin Battery (CN19)

CN19 is used for a coin battery. The pin assignment is shown as below.

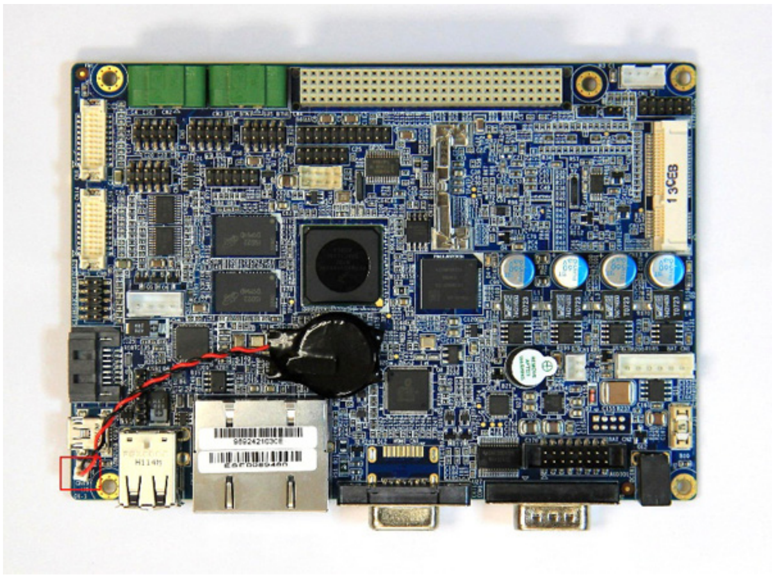


Figure 2.23 Wafer for Coin Battery

Pin	Description	Pin	Description
1	COIN_RTC	2	GND

2.2.19 SIM Card slot (CN20)

RSB-4210 provides a SIM card slot for MiniPCIe devices.

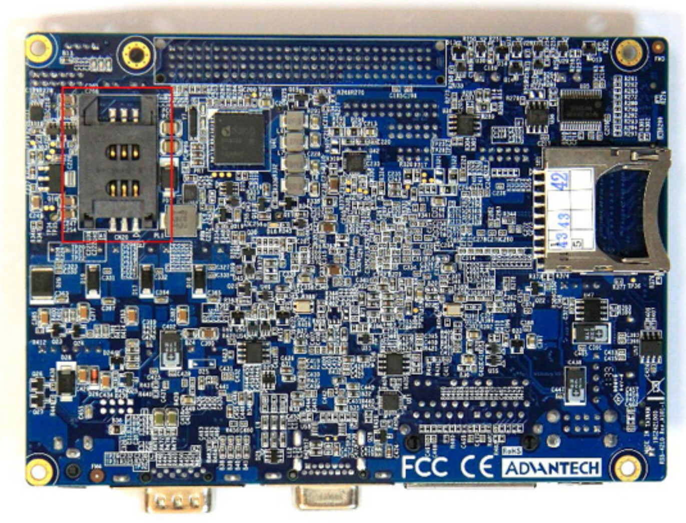


Figure 2.24 SIM Card slot

2.2.20 Pin Header for Reset (RST_BTN1)

RST_BTN1 is used for resetting the system. You can connect it with an external button for application. The pin assignment are shown below.

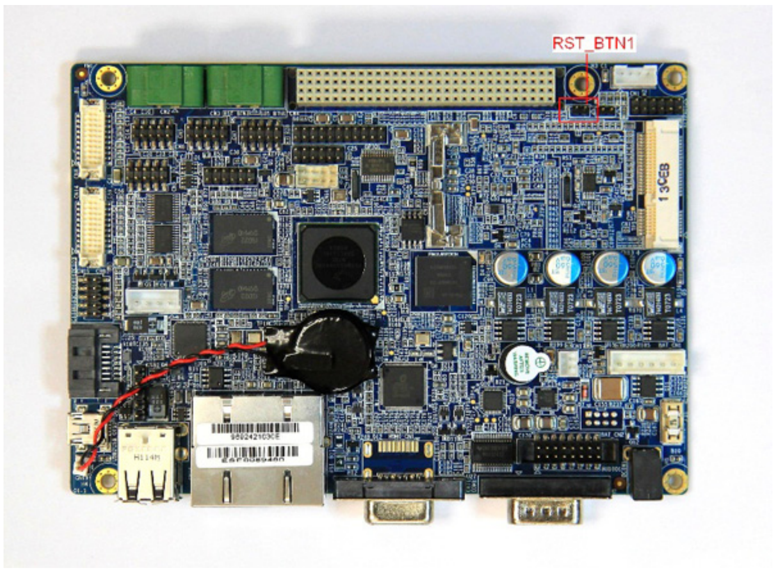


Figure 2.25 Pin Header for Reset

Pin	Description	Pin	Description
1	nRESET	2	GND

2.2.21 Pin Header for Suspend (SUS_BTN1)

SUS_BTN1 is used to making system entering into suspend mode or resume from suspend mode. You can connect it with an external button for applications. The pin assignment is shown as below.

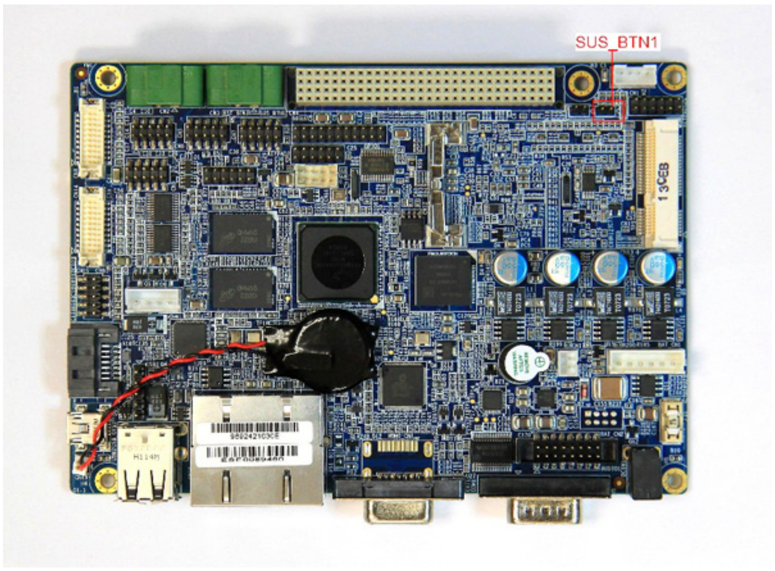


Figure 2.26 Pin Header for Suspend

Pin	Description	Pin	Description
1	nSUSPEND	2	GND

2.2.22 Pin Header for Matrix Keypad (KEYPAD1)

The keypad circuitry scans a 6*6 array of 36 normal-open, single-pole switches. Any one or two keys depressed will be de-bounced and decoded. An interrupt is generated whenever a stable set of depressed keys is detected. The keypad interface:

- Provides scanning, de-bounce, and decoding for a 36-key switch array
- Scans a 6-row by 6-column matrix
- May decode 2 keys at once
- Generates an interrupt when a new stable key is determined
- Generates a 3-key reset interrupt as well

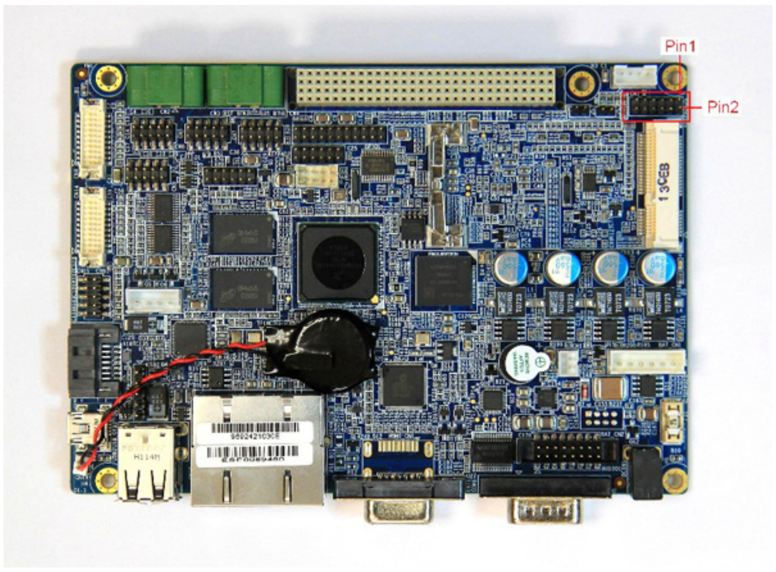


Figure 2.27 Pin Header for Matrix Keypad

Pin	Description	Pin	Description
1	KEY_COL2	2	KEY_ROW2
3	KEY_COL3	4	KEY_ROW3
5	KEY_COL4	6	KEY_ROW4
7	KEY_COL5	8	KEY_ROW5
9	KEY_COL6	10	KEY_ROW6
11	KEY_COL7	12	KEY_ROW7

2.2.23 Pin Header for I2C/SPI (CN21)

RSB-4210 provides two I2C and one SPI interface with user to expand their applications. CN21 is the pin header for I2C/SPI interface. The pin assignment is shown as below.

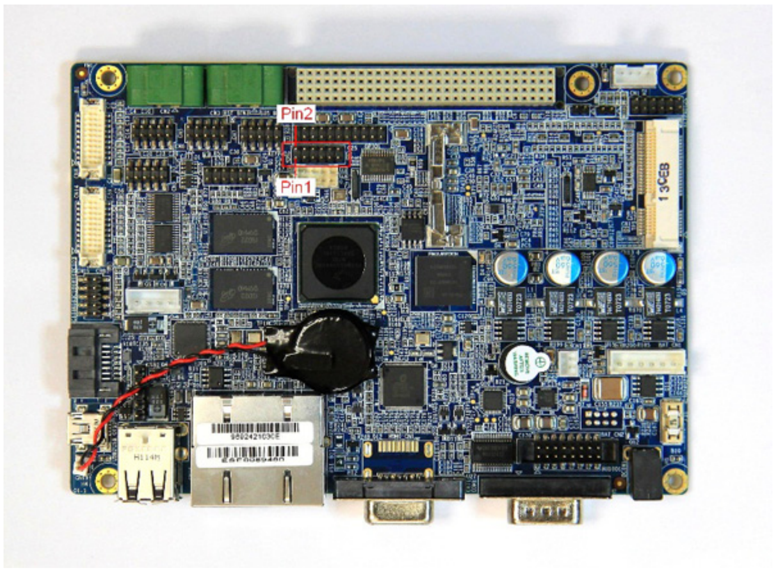


Figure 2.28 Pin Header for I2C/SPI

Pin	Description	Pin	Description
1	GND	2	SPI_IRQ
3	I2C1_SCL	4	SPI_MISO
5	I2C1_SDA	6	SPI_MOSI
7	I2C3_SCL	8	SPI_CS0
9	I2C3_SDA	10	SPI_CLK
11	DIO_3V3	12	DIO_3V3

2.2.24 Pin Header for 20x pins GPIO (GPIO1)

GPIO1 is extended for 20x pins 3.3V TTL Level GPIO. GPIO1~4 pins are coming from CPU directly while GPIO5~20 pins are extended from IC PCA9555. The pin assignment is shown as below.

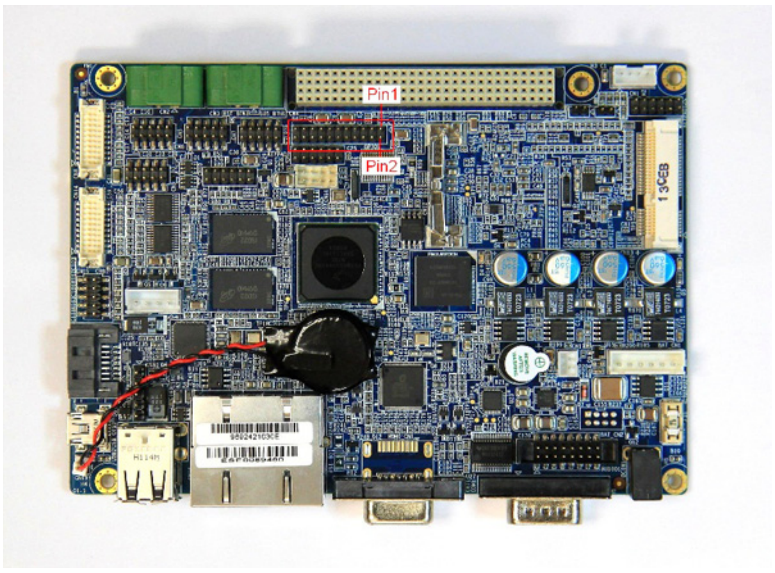


Figure 2.29 Pin Header for GPIO

Pin	Description	Pin	Description
1	GND	2	DIO_3V3
3	IMX_GPIO1	4	IMX_GPIO2
5	IMX_GPIO3	6	IMX_GPIO4
7	EX_GPIO_5	8	EX_GPIO_6
9	EX_GPIO_7	10	EX_GPIO_8
11	EX_GPIO_9	12	EX_GPIO_10
13	EX_GPIO_11	14	EX_GPIO_12
15	EX_GPIO_13	16	EX_GPIO_14
17	EX_GPIO_15	18	EX_GPIO_16
19	EX_GPIO_17	20	EX_GPIO_18
21	EX_GPIO_19	22	EX_GPIO_20

2.2.25 SATA Connector (SATA_CN1)

RSB-4210 supports one SATA Interface thru SATA_CN1. (Both SATA DOM and SATA HDD support.) The pin assignment is shown in Fig 2.30 below.

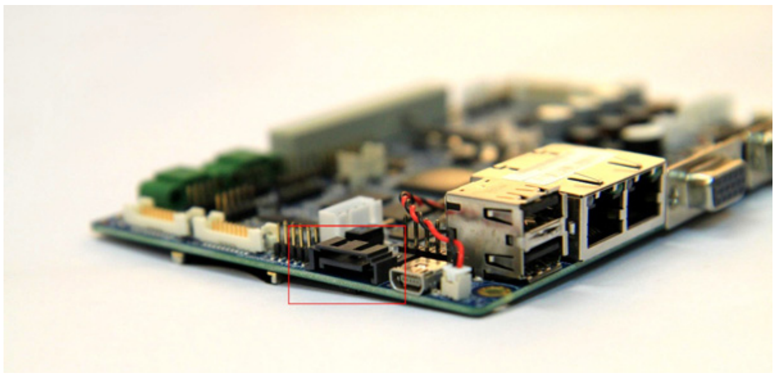


Figure 2.30 SATA Connector

Pin	Description	Pin	Description
1	GND	2	SATA_TX+
3	SATA_TX-	4	GND
5	SATA_RX-	6	SATA_RX+
7	GND		

2.2.26 Pin Header for USB_HUB1 (USB1)

The USB port is extended from USB_HUB1. The pin assignment is shown below.

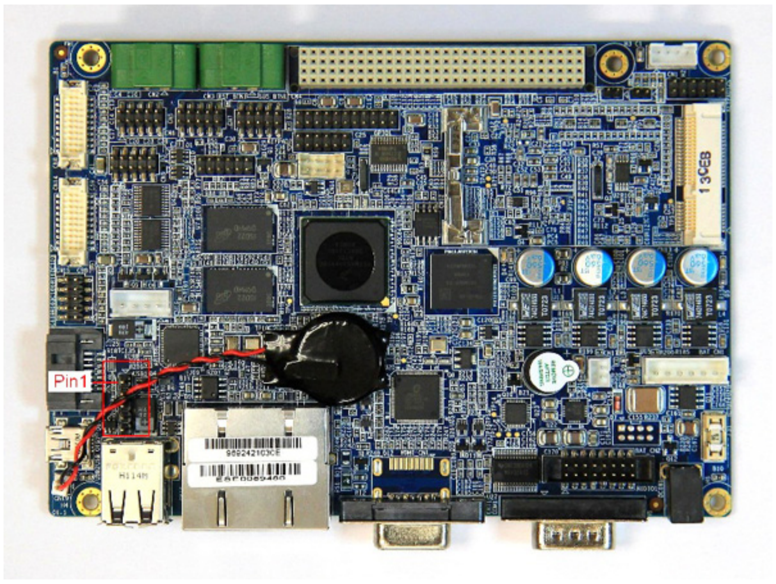


Figure 2.31 Pin Header for USB_HUB1

Pin	Description	Pin	Description
1	5V	2	CSB_HUB1_Data -
3	CSB_HUB1_Data +	4	GND
5	GND (Chassis Ground)		

2.2.27 Wafer for Battery Charger Board - Power (BAT_CN1)

BAT_CN1 provides the power with battery charger board. +VIN_ADP is the voltage from adapter to battery charge board; +VIN is the voltage from battery charge board to RSB-4210. The pin assignment is shown below.

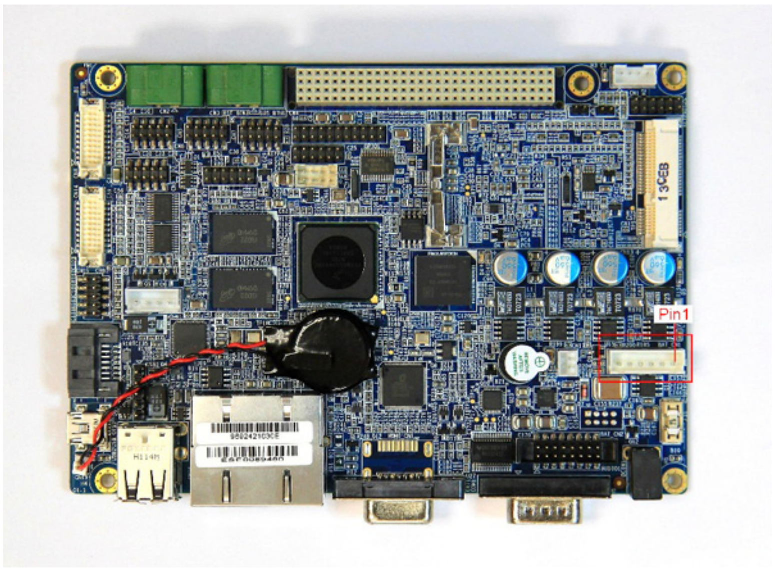


Figure 2.32 Wafer for Battery Charger Board - Power

Pin	Description	Pin	Description
1	+VIN_ADP (For Battery)	2	+VIN_ADP (For Battery)
3	GND	4	GND
5	+VIN (For RSB-4210)	6	+VIN (For RSB-4210)

2.2.28 Wafer for Battery Charger Board -Control Signal (BAT_CN2)

BAT_CN2 provides the I2C control signal with battery charger board. The pin assignment is shown below.

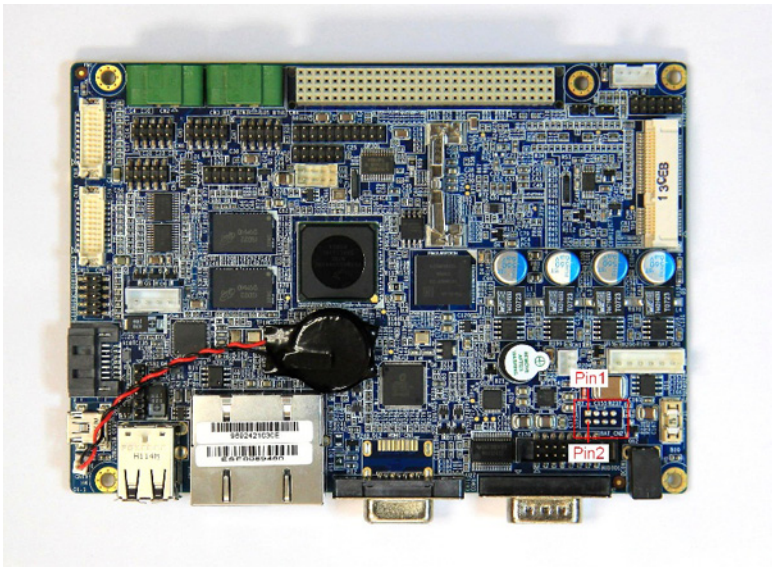


Figure 2.33 Wafer for Battery Charger Board - Control Signal

Pin	Description	Pin	Description
1	3.3 V_STB	2	GND
3	I2C3_SCL_BAT	4	N/C
5	I2C3_SDA_BAT	6	N/C
7	Charger_board_IN#	8	N/C

2.2.29 USB OTG MINI-AB Connector (USB_OTG1)

The RSB-4210 has a single USB OTG mini-AB port which can be used as a USB client to link with PC or a USB host device. For USB client applications, users could upload or download files to any folder in Windows CE and create a synchronous folder between PC and RSB-4210 thru this connector. For USB host applications, users can connect with USB devices, for example, USB mouse and USB keypad.

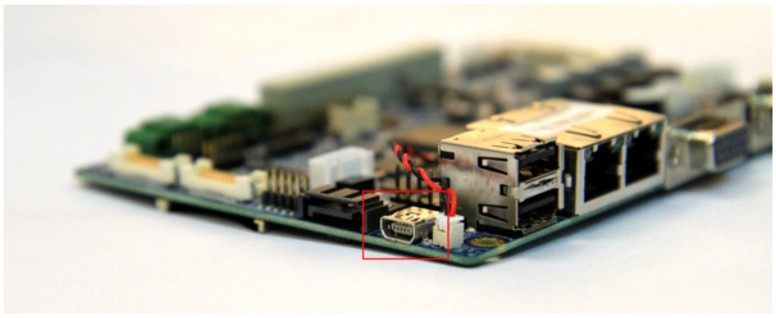


Figure 2.34 USB OTG MINI-AB Connector

Pin	Description	Pin	Description
1	5V	2	Data -
3	Data +	4	USBOTG_ID
5	GND		

2.2.30 USB HUB_2&3 (Standard Type-A) (USB2)

The USB interface provides full speed serial communications ports, which includes the following features:

- Compliance with the USB 2.0 specification
- Transceiver buffers integrated, over-current protection on ports
- Supports power management
- Operates as a master on the bus

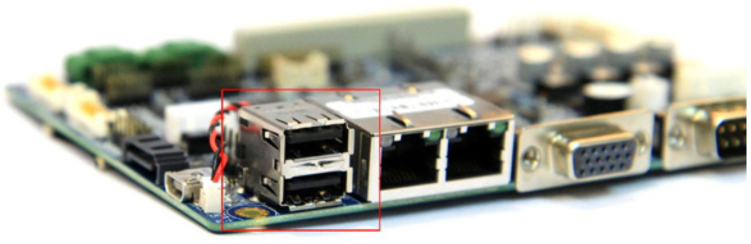


Figure 2.35 USB CSB_HUB_2&3 (Standard Type-A)

2.2.31 VGA Connector (CRT1)

RSB-4210 supports a standard VGA Interface (D-SUB15). The pin assignment is shown below.

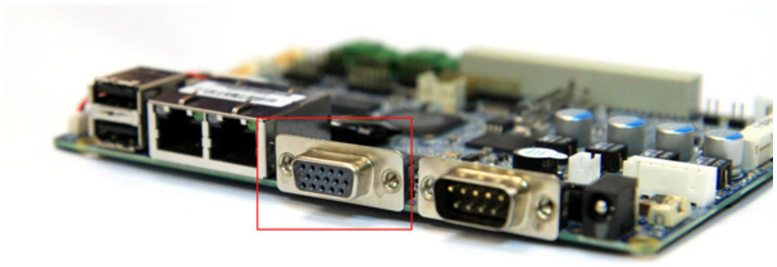


Figure 2.36 VGA Connector (D-SUB15)

Pin	Description	Pin	Description
1	CRT_R	2	CRT_G
3	CRT_B	4	N/C
5	GND	6	GND
7	GND	8	GND
9	+5 V	10	GND
11	N/C	12	DDC_SD_CRT
13	HSYNC	14	VSYNC
15	DDC_SC_CRT		

2.2.32 HDMI Connector (HDMI_CN1)

RSB-4210 supports a standard HDMI Interface. The pin assignment is shown below.

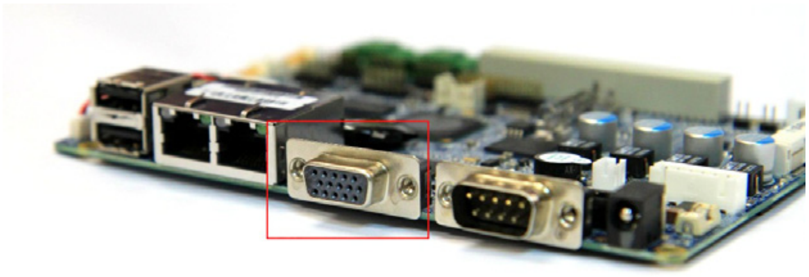


Figure 2.37 HDMI Connector

Pin	Description	Pin	Description
1	HDMI_TD2+	2	GND
3	HDMI_TD2-	4	HDMI_TD1+
5	GND	6	HDMI_TD1-
7	HDMI_TD0+	8	GND
9	HDMI_TD0-	10	HDMI_CLK+
11	GND	12	HDMI_CLK-
13	HDMI_CEC	14	HDMI_Reserved
15	DDC_SC_HD	16	DDC_SD_HD
17	GND	18	+5V_HDMI
19	HPD		

2.2.33 Box Header for LINE-OUT, LINE-IN, MIC-IN and L&R Speakers (AUDIO1)

The box header is used for audio input / output signal port, and the speaker-out uses a 2W amplifier. The pin assignment is shown below.

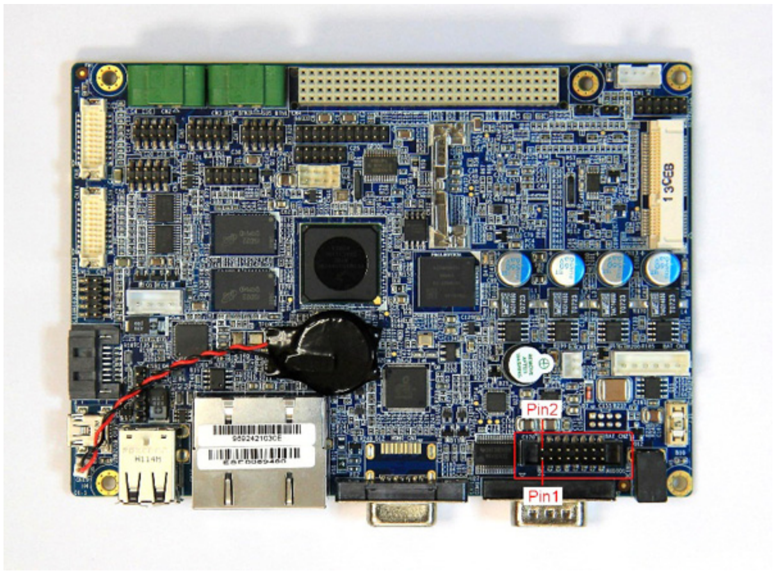


Figure 2.38 Box Header for LINE-OUT, LINE-IN, MIC-IN and L&R Speakers

Pin	Description	Pin	Description
1	LINE_OUT_R	2	SPK_R-
3	LINE_OUT_L	4	SPK_L-
5	SPK_R+	6	SPK_L+
7	N/C	8	AGND
9	LINE_IN_R	10	LINE_IN_L
11	N/C	12	AGND
13	N/C	14	N/C
15	MIC_IN	16	AGND

2.2.34 D-Sub9 Connector for COM2, RS-232 (TX/RX/RTS/ CTS) (COM1)

COM1 port supports RS-232 (TX/RX/RTS/CTS). The pin assignment is shown below.

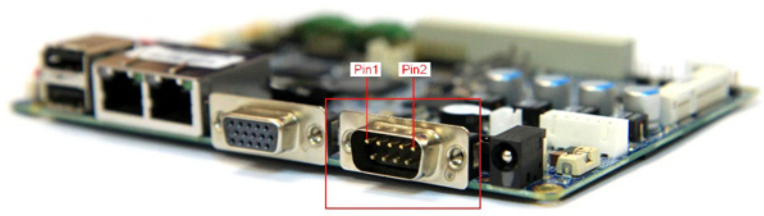


Figure 2.39 D-Sub9 Connector for COM2, RS-232 (TX/RX/RTS/CTS)

Pin	Description	Pin	Description

1	N/C	2	COM2_RXD
3	COM2_TXD	4	N/C
5	GND	6	N/C
7	COM2_RTS	8	COM2_CTS
9	N/C		

2.2.35 DC-IN Power Jack(DCIN1)

The DC-in power jack DCIN1 provides the power with RSB-4210 (+9 ~ 24 V).

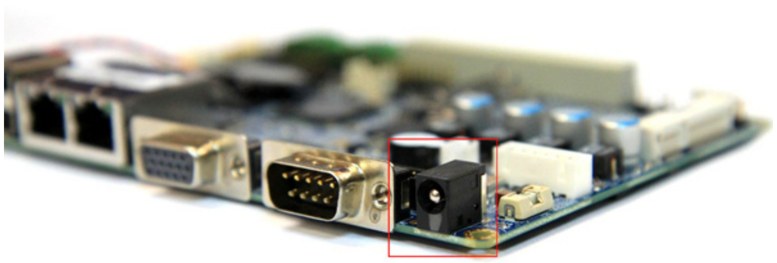


Figure 2.40 DC-IN Power Jack

2.2.36 SD Card Slot (SD1)

The SD card Slot (SD1) is powered with 3.3 V, which includes the following features:

- Fully compatible with the MMC system specification version 3.2
- Compatible with the SD Memory Card specification 1.01, and SD I/O specification 1.1 with 1/4 channel (s)
- Block-based data transfer between MMC card and SDHC (stream mode not supported)
- 100 Mbps maximum data rate in 4-bit mode, SD bus clock up to 25 MHz

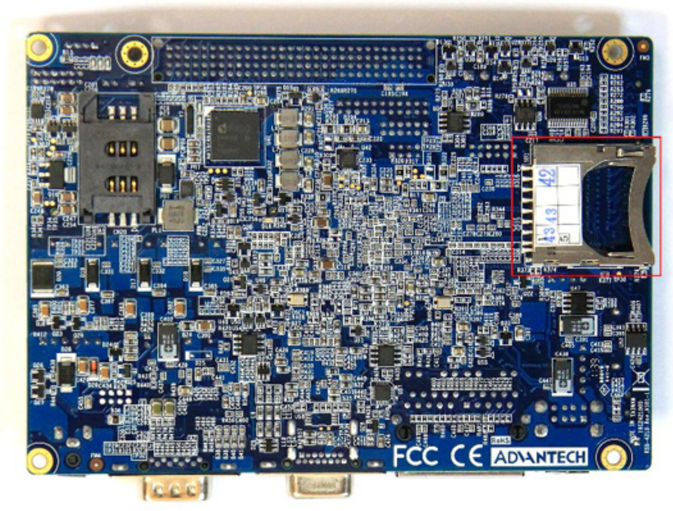


Figure 2.41 SD card Slot

2.3 Mechanical

2.3.1 Connector Location

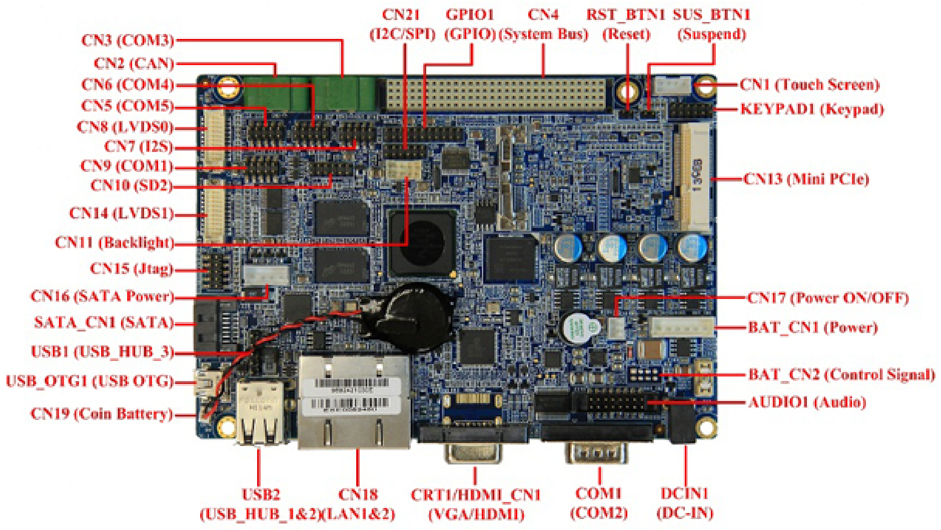


Figure 2.42 RSB-4210 Connector Position (Top)

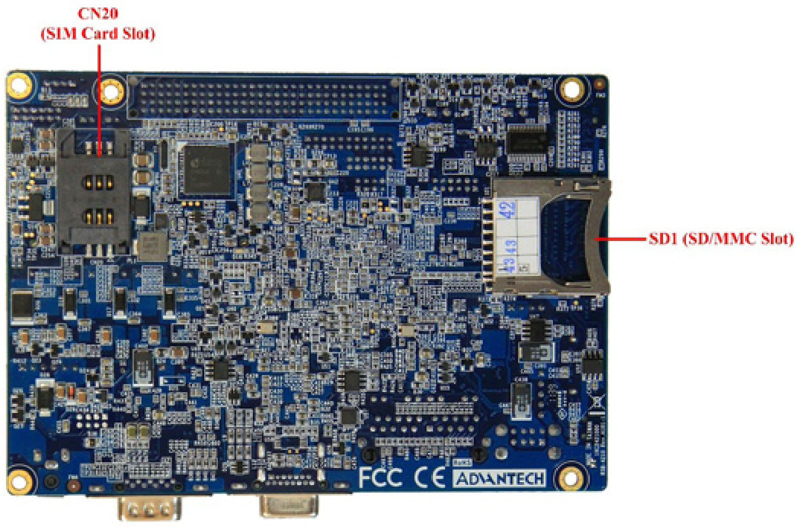


Figure 2.43 RSB-4210 Connector Position (Bottom)

2.3.2 RSB-4210 Board Dimension

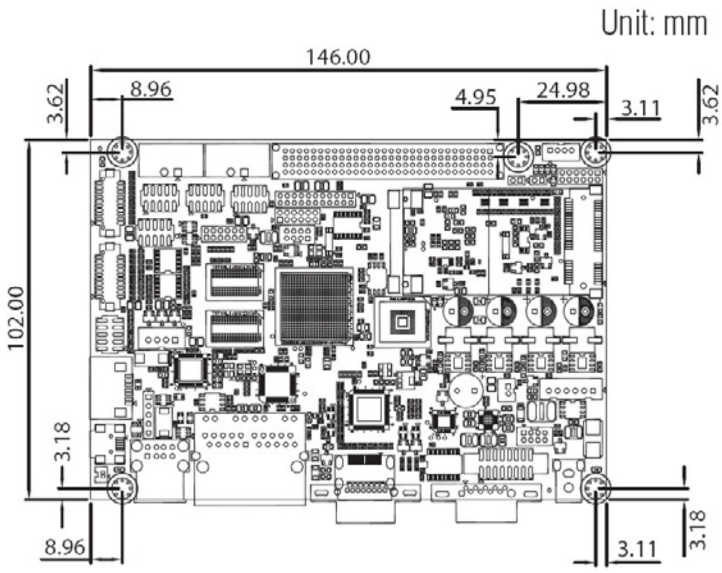


Figure 2.44 RSB-4210 Board Dimension

Chapter 3

Software Functionality

This chapter details the Linux operating system on RSB-4210.

3.1 Introduction

The RSB-4210 platform is an embedded system with Linux kernel 2.6.35 as default. Its major functions include all system-required shell commands and drivers ready for RSB-4210 platform. Advantech’s Linux package does not offer a development environment. Users can develop it under an Ubuntu environment.

There are three major boot components for Linux, "u-boot.bin", "uImage" and "File System". The "u-boot.bin" is for initial peripheral hardware parameter. The "uImage" is the Linux kernel image. And the "File System" is for Linux O.S. used.

The system will not boot into a Linux environment successfully if one of these files does not exist on the boot media (SD storage card or onboard flash).

The purpose of this chapter is to get you going with developing software for the RSB-4210 on a Linux development host only.

Note! *All instructions in this guide are for Ubuntu 10.04 LTS. At this time, it is the only supported Linux host distribution for development.*

Note! *The "u-boot.bin" file has been installed on NOR flash of RSB-4210 as default.*

3.2 Package Content

There are two kinds of Linux package for RSB-4210. One is for making Linux system SD storage card, and another is source code package.

3.2.1 Package for Making Linux System SD Storage Card

RSB-4210 supports booting from SD storage card. Users can use this package to make a Linux system SD storage card. The package contains mkmmc-linux.sh, u-boot.bin, uImage and rootfs folder.

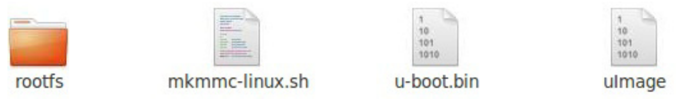


Figure 3.1 Contents of package for making Linux system SD storage card

The description of RSB-4210_Linux_system_SD package contents:

- mkmmc-linux.sh → A script to make the Linux system SD card quickly.
- u-boot.bin → U-boot image
- uImage → Linux kernel image
- rootfs → Root file system (include "mk_inand")

Note! *Please contact with your Advantech contact window if you need it.*

3.2.2 Source Code Package

RSB-4210 source code package contains many software components which are accessed by RSB-4210 products. Some are developed by Advantech and some are developed in and by the open source community. This package contains seven main folders, "cross_compiler", "image", "logo", "mk_inand", "rootfs", "scripts", and "source".

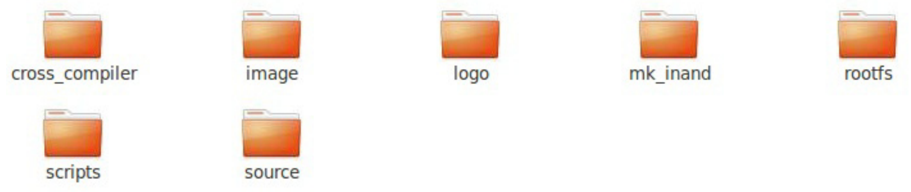


Figure 3.2 Contents of Source code package

The description of RSB-4210_Linux_Source_Code package contents:

- "cross_compiler'" → This folder contains source code for cross compiler.
- "image" → This folder contains the uImage, and the script for making Linux system media automatically.
- "logo" → This folder contains Advantech logo.
- "mk_inand" → Linux system files for onboard flash/SATA disk booting used. (Including mkmmc-linux.sh/mksata-linux.sh, u-boot.bin, uImage, sfdisk.)
- "rootfs" → This folder contains source code for Linux file system
- "scripts" → This folder contains scripts for configure system and compile images automatically.
- "source" → This folder contains source code for Linux kernel image

3.2.2.1 Cross Compiler

You can use the cross compiler to compile the uImage and related applications.

(gcc version is 4.4.4_09_06_2010)

3.2.2.2 Image

This folder includes the files as follows:

- mkmmc-linux.sh → A script to make the Linux system SD card quickly.
- u-boot.bin → U-boot image
- uImage → Linux kernel image

And the "uImage" is compiled from Chapter 3.1.2.5.

3.2.2.3 Rootfs (Root File System)

The Linux root file system is usually thought of in a tree structure. The tree of the file system starts at the trunk or slash, indicated by a forward slash (/). This directory, containing all underlying directories and files, is also called the root directory or "the root" of the file system.

Directories that are only one level below the root directory are often preceded by a slash, to indicate their position and prevent confusion with other directories that could have the same name. When starting with a new system, it is always a good idea to take a look in the root directory.

The main folders contained in "rootfs" are listed as follows:

- bin' → Common programs, shared by the system, the system administrator and the users.

- boot' → The startup files and the kernel. In some recent distributions also grub data. Grub is the Grand Unified Boot loader and is an attempt to get rid of the many different boot-loaders we know today.
- dev' → Contains references to all the CPU peripheral hardware, which are represented as files with special properties.
- etc' → Most important system configuration files are in /etc, this directory contains data similar to those in the Control Panel in Windows
- home' → Home directories of the common users.
- lib' → Library files, includes files for all kinds of programs needed by the system and the users.
- lost+found' → Every partition has a lost+found in its upper directory. Files that were saved during failures are here.
- mnt' → Standard mount point for external file systems.
- opt'Typically contains extra and third party software.
- proc' → A virtual file system containing information about system resources. More information about the meaning of the files in proc is obtained by entering the command man proc in a terminal window. The file proc.txt discusses the virtual file system in detail.
- root' → The administrative user's home directory. Mind the difference between /, the root directory and /root, the home directory of the root user.
- sbin' → Programs for use by the system and the system administrator.
- tmp' → Temporary space for use by the system, cleaned upon reboot, so doesn't use this for saving any work!
- usr' → Programs, libraries, documentation etc. for all user-related programs.
- var' → Storage for all variable files and temporary files created by users, such as log files, the mail queue, the print spooler area, space for temporary storage of files downloaded from the Internet.

3.2.2.4 Scripts

Some scripts developed by Advantech will help you configure system or build the images more quickly. Please check them as follows:

- setenv.sh → A script to setup the developing environment quickly.
- cfg_kernel.sh → A script to configure the kernel building setup quickly.
- mk_kernel.sh → A script to build the kernel(uImage) and copy the "uImage" to "image" and "mk_inand" folders after building.
- cfg_uboot.sh → A script to configure the u-boot building setup quickly.
- mk_uboot.sh → A script to build the u-boot(u-boot.bin) and copy the "u-boot.bin" to "image" and "mk_inand" folders after building.

3.2.2.5 Source

The source folder contains folder- "linux-2.6.35.3". It is the source code for Linux kernel image.

Linux is a clone of the operating system UNIX. It has all the features you would expect in a modern fully-fledged UNIX, including true multitasking, virtual memory, shared libraries, demand loading, shared copy-on-write executables, proper memory management, and multitask networking including IPv4 and IPv6.

Linux is easily portable to most general-purpose 32- or 64-bit architectures as long as they have a paged memory management unit (PMMU) and a port of the GNU C compiler (gcc) (part of The GNU Compiler Collection, GCC). Linux has also been ported to a number of architectures without a PMMU, although functionality is then obviously somewhat limited. Linux has also been ported to itself. You can now run the kernel as a user space application - this is called User Mode Linux (UML).

The main folders contained in "linux-2.6.35.3" are listed as follows:

- arch' → The items related to hardware platform, most of them are for CPU.
- block' → The setting information for block.
- crypto' → The encryption technology that kernel supports.
- Documentation' → The documentation for kernel.
- drivers' → The drivers for hardware.
- firmware' → Some of firmware data for old hardware.
- fs' → The file system the kernel supports.
- include' → The header definition for the other programs used.
- init' → The initial functions for kernel.
- ipc' → Define the communication for each program of Linux O.S.
- kernel' → Define the Kernel process, status, schedule, signal.
- lib' → Some of libraries.
- mm' → The data related the memory.
- net' → The data related the network.
- security' → The security setting.
- sound' → The module related audio.
- virt' → The data related the virtual machine.

There are plenty of documentation or materials available on the Internet and in books, both Linux-specific and pertaining to general UNIX questions.

And there are various README files in the /linux-2.6.35.3/Documentation: these typically contain kernel-specific installation notes for some drivers for example. See Documentation/00-INDEX for a list of what is contained in each file.

3.3 Setup Building Environment

All instructions in this guide are for Ubuntu 10.04 LTS. Please install the Ubuntu 10.04 LTS at your PC/NB in advance.

When you got the RSB-4210 Linux source code package, you can refer to the following steps to unzip to your developing environment:

1. Copy "RSB4210_Linux_BSP.tar.gz" package to your desktop.
2. Open "Terminal" utility.
3. Type `#sudo su` (Change to "root" authority)
4. Type `user password`
5. Type `#cd Desktop/`
6. Type `#tar xvf RSB4210_Linux_BSP.tar.gz` (Unzip file)
7. Then you can see folder "RSB4210_BSP" on desktop
8. Finish.

Advantech has written a script to setup the developing environment quickly. You can refer to the following steps to setup your development environment:

1. Open "Terminal" utility
2. Type `#sudo su` (Change to "root" authority)
3. Type user password
4. Type `#cd Desktop/RSB4210_BSP/scripts/`
5. Type `#. setenv.sh` (To configure the developing environment automatically)
6. Then you can start to code the source code, build images, or compile applications.

3.3.1 Setenv.sh

The script "setenv.sh" is mainly used to configure the developing environment quickly. It will configure the important folder paths for system, and you can also add/ modify the setenv.sh by yourself if you have added/changed the folder paths.

The default code of setenv.sh is shown as following:

```
#!/bin/bash
export SRCROOT=${PWD}/..
export CC_PATH=${SRCROOT}/cross_compiler/arm-fsl-linux-gnueabi
export CROSS_COMPILE=$CC_PATH/bin/arm-none-linux-gnueabi-
export ARCH=arm
export KROOT=${SRCROOT}/source/linux-2.6.35.3
export ROOTFS=${SRCROOT}/rootfs
export LOG=${SRCROOT}/Build.log
rm -rf ${LOG}
```

Note! *You have to run "setenv.sh" once you open a new "Terminal" utility every time.*

Note! *It is suggested to change to "root" authority to use the source code.*

3.4 Building Instructions

This section will guide you how to build the U-boot - "u-boot.bin" and the Linux kernel - "uImage".

3.4.1 Building U-boot image "u-boot.bin"

Advantech has written a script to build the "u-boot.bin" quickly. You can build the image by following these steps:

1. Open "Terminal" utility.
2. Type `#sudo su` (Change to "root" authority)
3. Type user password
4. Type `#cd Desktop/RSB4210_BSP/scripts/`
5. Type `#. setenv.sh` (To configure the developing environment automatically)
6. Type `#. cfg_uboot.sh` (To set the u-boot.bin configuration automatically)
7. Type `#. mk_uboot.sh` (Start to build the u-boot.bin)
8. Then you can see "u-boot.bin" under folders "image" and "mk_inand"
9. Finish.

3.4.2 Building Linux Kernel image "uImage"

Advantech has written a script to build the "uImage" quickly. You can build the image by referring to the following steps:

1. Open "Terminal" utility.
2. Type `#sudo su` (Change to "root" authority)
3. Type user password

4. Type `#cd Desktop/RSB4210_BSP/scripts/`
5. Type `#. setenv.sh` (To configure the developing environment automatically)
6. Type `#apt-get install libncurses5-dev` (To get the menuconfig library)
7. Type `#apt-get install jigit` (To get mkimage)
8. Type `#. cfg_kernel.sh` (To set the uImage configuration automatically)
9. Type `#. mk_kernel.sh` (Start to build the uImage)
10. Then you can see "uImage" under folders "image" and "mk_inand"
11. Finish.

3.4.3 Build Log

When an error occurs during building kernel, it will record in this file. This build.log is under folder "/RSB4210_BSP".

3.5 Source Code Modification

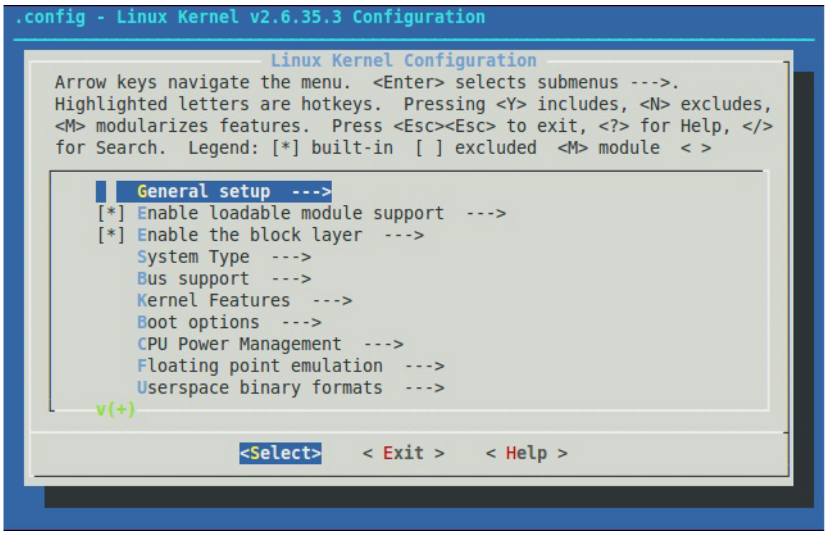
This section will guide you how to use the Linux source code. Several examples for source code applications will be shown in this section as well.

3.5.1 Adding a Driver to Kernel by menuconfig

You can add a driver to kernel by menuconfig. Here is an example to guide you adding a RTC driver (Seiko Instruments S-35390A) to Linux kernel. Please refer to the following steps:

Example:

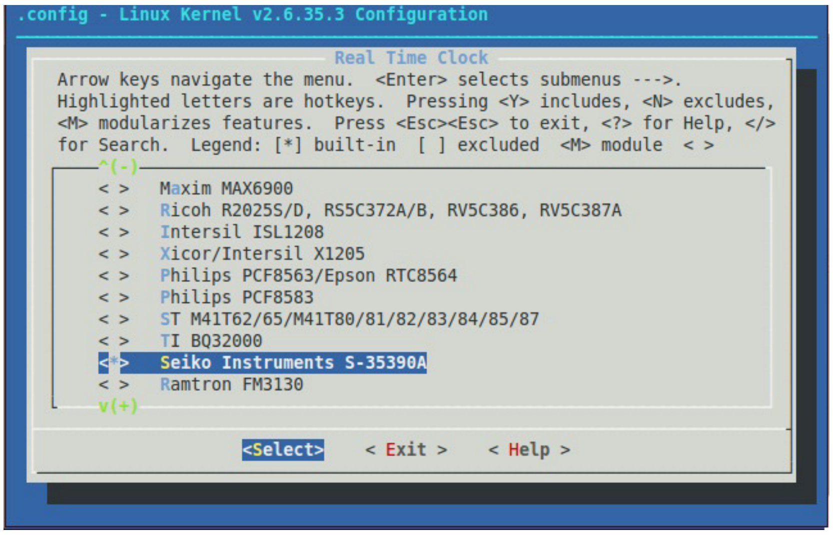
1. Open "Terminal" utility.
2. Type `#sudo su` (Change to "root" authority)
3. Type user password
4. Type `#cd Desktop/RSB4210_BSP/scripts/`
5. Type `#. setenv.sh` (To configure the developing environment automatically)
6. Type `#. cfg_kernel.sh menuconfig`
7. Then you will see a GUI screen (Linux Kernel Configuration) as below:



```
.config - Linux Kernel v2.6.35.3 Configuration
                    Linux Kernel Configuration
  Arrow keys navigate the menu.  <Enter> selects submenus --->.
  Highlighted letters are hotkeys.  Pressing <Y> includes, <N> excludes,
  <M> modularizes features.  Press <Esc><Esc> to exit, <?> for Help, </>
  for Search.  Legend: [*] built-in  [ ] excluded  <M> module  < >

          General setup  --->
      [*] Enable loadable module support  --->
      [*] Enable the block layer  --->
          System Type  --->
          Bus support  --->
          Kernel Features  --->
          Boot options  --->
          CPU Power Management  --->
          Floating point emulation  --->
          Userspace binary formats  --->
      v(+)

              <Select>    < Exit >    < Help >
```

Figure 3.3 Linux Kernel Configuration

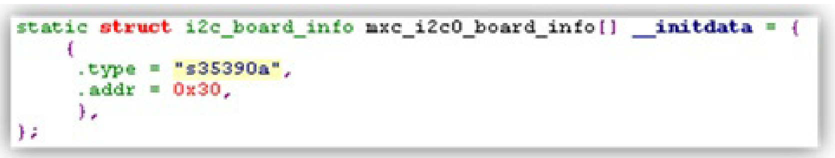
8. Go to "Device Drivers""Real Time Clock", then you can see the "Seiko Instruments S-35390A" on the list. Select this option then exit and save the configuration.



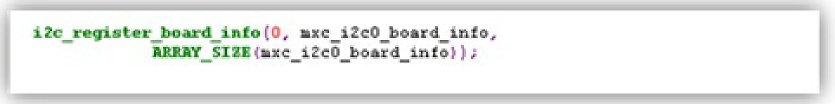
```
.config - Linux Kernel v2.6.35.3 Configuration
                              Real Time Clock
  Arrow keys navigate the menu.  <Enter> selects submenus --->.
  Highlighted letters are hotkeys.  Pressing <Y> includes, <N> excludes,
  <M> modularizes features.  Press <Esc><Esc> to exit, <?> for Help, </>
  for Search.  Legend: [*] built-in  [ ] excluded  <M> module  < >
      ^(-)
      < >   Maxim MAX6900
      < >   Ricoh R2025S/D, RS5C372A/B, RV5C386, RV5C387A
      < >   Intersil ISL1208
      < >   Xicor/Intersil X1205
      < >   Philips PCF8563/Epson RTC8564
      < >   Philips PCF8583
      < >   ST M41T62/65/M41T80/81/82/83/84/85/87
      < >   TI BQ32000
      <*>   Seiko Instruments S-35390A
      < >   Ramtron FM3130
      v(+)

                    <Select>    < Exit >    < Help >
```

Figure 3.4 Selecting Seiko Instruments S-35390A

9. Go to folder "source/linux-2.6.35.3/arch/arm/mach-mx5", and edit the "mx53_smd.c", to add these codes.



```
static struct i2c_board_info mxc_i2c0_board_info[] __initdata = {
    {
     .type = "s35390a",
     .addr = 0x30,
     },
};
```



```
  i2c_register_board_info(0, mxc_i2c0_board_info,
              ARRAY_SIZE(mxc_i2c0_board_info));
```

Figure 3.5 Integrate Code for Seiko Instruments S-35390A

10. Then you can refer to Chapter 3.3.2 to rebuild the kernel with RTC driver (Seiko Instruments S-35390A).

Note! *If you cannot find any drivers for your hardware, you should contact your hardware vendor.*

3.5.2 Changing the Boot Logo

System will show the boot logo when booting up RSB-4210. You can replace the default boot logo with yours by referring to the following steps:

1. You have to download "netpbm" package firstly, then install it by typing #sudo apt-get install netpbm .
2. Prepare a picture for boot logo. For example: bootlogo.png (Under folder Desktop/bootlogo)

Note! *This picture should be PNG format that under 224 kinds of colors. And it is better when the image resolution and LCD panel size are equal.*

3. Open "Terminal" utility.
4. Type `#cd Desktop/bootlogo` (Go into the folder that bootlogo.png located)
5. Type `#pngtopnm bootlogo.png | pnmtoplainpnm > logo_linux_clut224.ppm`
6. Type `#cp logo_linux_clut224.ppm /home/user/Desktop/RSB4210_BSP/source/`linux-2.6.35.3/drivers/video/logo
7. Then you can refer Chapter 3.3.2 to rebuild the kernel with your own boot logo.

3.6 Making Linux System Booting Media

RSB-4210 supports booting from SD storage card and onboard flash. This section will guide you how to make the Linux system boot media for RSB-4210.

3.6.1 Making a Linux System SD Storage Card

3.6.1.1 From Linux_System_SD Package

When you get the package for making a Linux system SD storage card, you can refer to the following steps to make it for booting, and Advantech has developed a script "mkmmc-linux.sh)" to help you build the "uImage" quickly.

1. Copy "RSB4210_Linux_image.tar.gz" package to your desktop.
2. Open "Terminal" utility.
3. Type `#sudo su` (Change to "root" authority)
4. Type your password.
5. Type `#cd Desktop/`
6. Type `#tar xvf RSB4210_Linux_image.tar.gz` (Unzip files)
7. Insert one SD card to your developing computer
8. Type `#df -h 'to check the SD card code name` (EX: /dev/sdf)
9. Type `#cd Desktop/RSB-4210_Linux_image`
10. Type `#./mkmmc-linux.sh /dev/sdf u-boot.bin uImage rootfs`
11. Type `#y` (Start to copy files, waiting a few minutes until it shows [Done])
12. Finish.

Then insert the Linux system SD storage card to CN41 of RSB-4210 and it will boot into the Linux environment after powering on the device.

3.6.1.2 From Source Code Package

When you get the RSB-4210 Linux source code package, you can refer to the following steps to make a Linux system SD storage card for booting, and Advantech has written a script "mkmmc-linux.sh" to help you to build the "uImage" quickly.

1. Open "Terminal" utility.
2. Type `#sudo su` (Change to "root" authority)
3. Type your password.
4. Insert one SD card to your developing computer
5. Type `#df -h` 'to check the SD card code name (EX: /dev/sdf)
6. Type #cd Desktop/RSB4210_BSP/image/

7. Type #./mkmmc-linux.sh /dev/sdf u-boot.bin uImage ../rootfs
8. Type #y (Start to copy files, waiting few minutes until it shows [Done])
9. Finish.

Then insert the Linux system SD storage card to CN41 of RSB-4210 and it will boot into the Linux environment when powering up the device.

3.6.2 Booting from Onboard Flash

Another way to boot up RSB-4210 is through the onboard flash. The script "mkmmc-linux.sh" will help you to build a "uImage" .

1. Refer to Chapter 3.4.1 to make a Linux system SD storage card
2. Demount SD card from File Browser and remove it.
3. Insert this Linux system SD card to RSB-4210 and boot into Linux.
4. On RSB-4210 platform, type #root (login)
5. On RSB-4210 platform, type #cd /mk_inand
6. On RSB-4210 platform, type #sh mkmmc-linux.sh /dev/mmcblk0 u-boot.bin uImage rootfs.tar.gz
7. On RSB-4210 platform, type #y (Start to copy files, waiting a few minutes until it shows [Done])
8. Power off and remove this SD card.
9. Finish.

Now you can boot from the onboard flash without an SD card.

3.6.3 Booting from SATA DOM

When you get the package for making a Linux system SD storage card, you can refer to the following steps to boot from SATA DOM. The script "mkmmc-linux.sh" will help you build a "uImage".

1. Refer to Chapter 3.4.1 to make a Linux system SD storage card
2. Demount SD card from File Browser and remove it.
3. Insert this Linux system SD card to RSB-4210 and boot into Linux.
4. On RSB-4210 platform, type #root (login)
5. On RSB-4210 platform, type #cd /mk_inand
6. On RSB-4210 platform, type #sh mkmmc-linux.sh /dev/sda u-boot.bin uImage rootfs.tar.gz
7. On RSB-4210 platform, type #y (Start to copy files, waiting a few minutes until it shows [Done])
8. Power off and remove this SD card.
9. Finish.

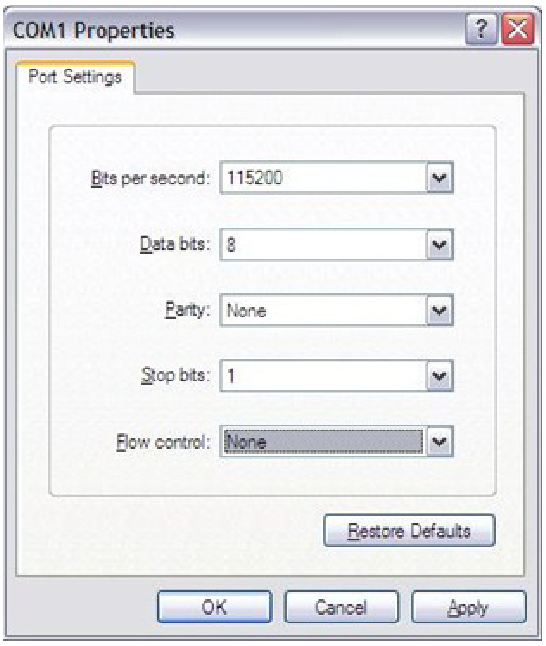
Now you can boot from onboard flash without SD card.

3.7 Debug Message

RSB-4210 can communicate with a host server (Windows or Linux) by using serial cables. Common serial communication programs such as HyperTerminal, Tera Term or PuTTY can be used in this case. The example below describes the serial terminal setup using HyperTerminal on a Windows host:

1. Connect RSB-4210 (UART1, CN27 of RTX-CSB) to your Windows PC by using a serial cable.
2. Open HyperTerminal on your Windows PC, and select the settings shown in Figure 3-6.

3. After the bootloader is programmed on SD card, press "POWER" key to power up the board. The bootloader prompt is displayed on the terminal screen.


COM1 Properties

Port Settings

Bits per second: 115200

Data bits: 8

Parity: None

Stop bits: 1

Flow control: None

Figure 3.6 HyperTerminal Settings for Terminal Setup

3.8 Linux Software Applications on RSB-4210

This section will guide you to develop your own application under Linux. Firstly an example "Hello World" will be shown, and some of the pre-installed applications on RSB-4210 platform will be introduced in detail then.

3.8.1 Writing Your Own "Hello World!" program on RSB-4210

This section will guide you how to write the sample program "Hello World". Follow these steps:

1. Open "Terminal" utility
2. Type `#sudo su` (Change to "root" authority)
3. Type user password.
4. Type `#cd Desktop/RSB-4210_BSP/scripts/`
5. Type `#. setenv.sh` (To configure the developing environment automatically)
6. Type `#cd /home/user/Desktop`
7. Type `#mkdir helloworld` (Create your own work directory on the Desktop)
8. Type `#cd helloworld` (Enter the work directory)
9. Type `# gedit helloworld.c` (Create a new C source file)
10. Edit the helloworld.c with the following source code:

```
#include <stdio.h>
void main()
{
printf("Hello World!\n");
}
```

11. Save the file and exit.
12. Type `#$CC -o helloworld helloworld.c` (To compile helloworld.c)
13. Then you can see "helloworld" in the work directory. (/Desktop/helloworld/)
14. Insert the Linux system SD card to your development computer.
15. Type `#cp helloworld /media/rootfs/tool` (/media/rootfs is the partition of your Linux system SD card)
16. Remove this SD card and insert it to RSB-4210 for booting.
17. On RSB-4210 platform, type `#root` (login)
18. On RSB-4210 platform, type `#cd /tool`
19. On RSB-4210 platform, type `#./helloworld`
20. Finished. "Hello World!" will be displayed on RSB-4210.

3.8.2 Running Pre-installed Applications on RSB-4210

The filesystem comes with a number of pre-installed applications. This section shows how to execute those applications in the provided filesystem.

3.8.2.1 Running QT Demos

There are many QT demo applications at path /usr/share/QT/demos.

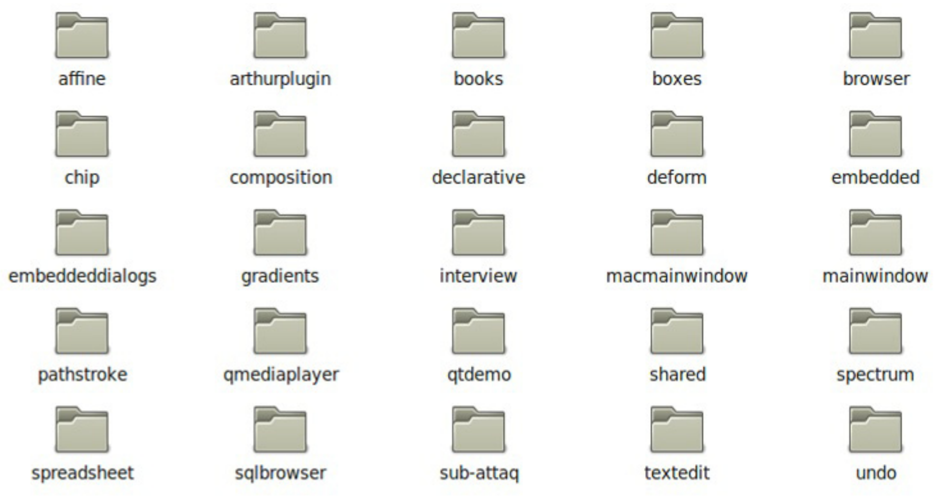


Figure 3.7 QT Demo Applications

Below is an example for Fluidlauncher QT demo application. Execute the following commands to run this QT demo application on RSB-4210:

Example:

1. Type `#root` (login)
2. Type `#cd /usr/share/QT/demos/embedded/fluidlauncher`
3. Type `#./fluidlauncher -qws`
4. Then you can see the Fluidlauncher demo on the LCD panel.

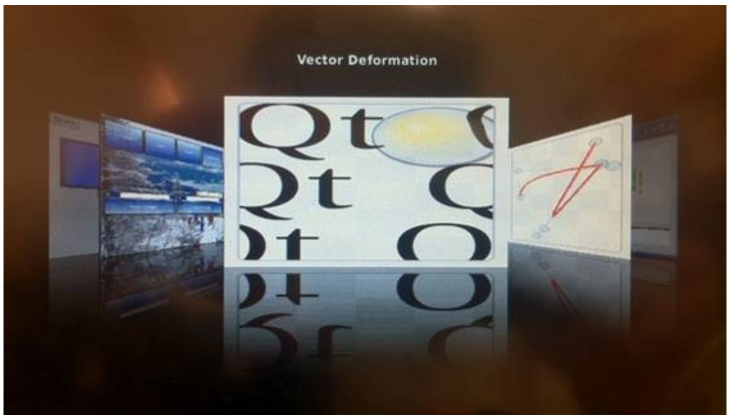


Figure 3.8 QT - Fluidlauncher demo

3.8.2.2 Running Audio Demo

Execute the following commands to run the Audio demo application on RSB-4210.

1. Type `#root` (login)
2. Type `#cd /unit_tests`
3. Type `#aplay audio8k16S.wav`
4. You should be able to hear music from the speaker/head-sets.

3.8.2.3 Running Video Demo

Execute the following commands to run the Video demo application on RSB-4210.

1. Type `#root` (login)
2. Type `#cd /unit_tests`
3. Type `#gplay akiyo.mp4`
4. Then you can watch the video demo on the LCD panel.

Figure 3.9 Video demo

3.8.2.4 Running Photo Demo

Execute the following commands to run the Photo demo application on RSB-4210.

1. Type `#root` (login)
2. Type `#cd /tools`
3. Type `#./fbv Advantech.JPG`
4. Then you can see the photo demo on the LCD panel.

Figure 3.10 Photo demo

3.8.2.5 Running Buzzer Testing

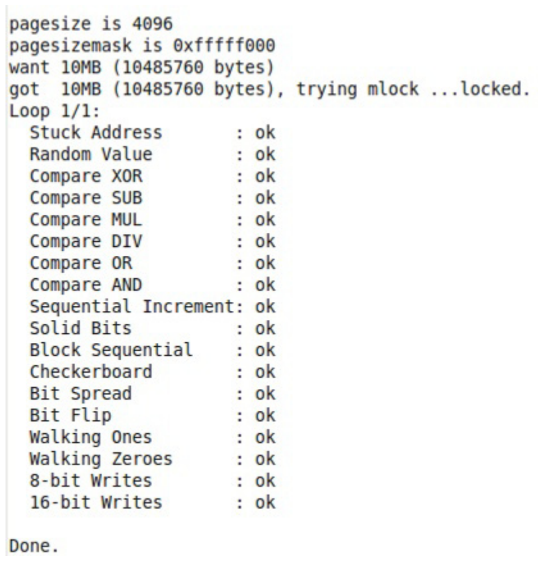
Execute the following commands to test the buzzer function of RSB-4210.

1. Type `#root` (login)
2. Type `#cd /tools`
3. Type `#./test_buzzer.sh`
4. You should hear the buzzer sound from RSB-4210.

3.8.2.6 Running Memory Testing

Execute the following commands to test the memory of RSB-4210.

1. Type `#root` (login)
2. Type `#cd /tools`
3. Type `#./memtester 10M 1` (Testing Size=10M Bytes; Loop=1 time)
4. Then system will start to test and show the memory testing result.



```
pagesize is 4096
pagesizemask is 0xfffff000
want 10MB (10485760 bytes)
got  10MB (10485760 bytes), trying mlock ...locked.
Loop 1/1:
  Stuck Address       : ok
  Random Value        : ok
  Compare XOR         : ok
  Compare SUB         : ok
  Compare MUL         : ok
  Compare DIV         : ok
  Compare OR          : ok
  Compare AND         : ok
  Sequential Increment: ok
  Solid Bits          : ok
  Block Sequential    : ok
  Checkerboard        : ok
  Bit Spread          : ok
  Bit Flip            : ok
  Walking Ones        : ok
  Walking Zeroes      : ok
  8-bit Writes        : ok
  16-bit Writes       : ok

Done.
```

Figure 3.11 Result of memory testing

3.9 VGA/HDMI Configuration on RSB-4210

In this section, we will introduce how to configure VGA/HDMI on RSB-4210. As depicted in Figure 3-12, IC CH7033B on RSB-410 board will be used for transferring TTL signal to VGA/HDMI output.

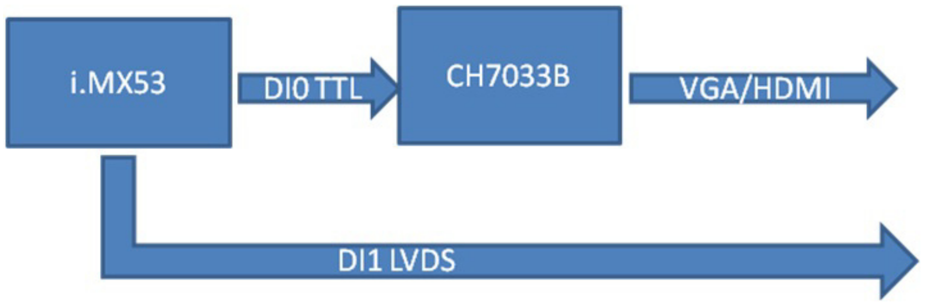


Figure 3.12 Block diagram of video configuration on RSB-4210

There are two output modes for VGA/HDMI signals on RSB-4210 as shown below:

- Auto mode: CH7033B controls output timing.
- Bypass mode: CPU Freescale i.MX53 controls output timing.

The following sections will introduce each of the output modes in detail.

Note! *Several resolution settings of your panel might cause the screen output to be partially cut. This is due to panel compatibility limitations. To solve this issue, it is necessary to fine tune the timing for specific resolution settings of your panel.*

3.9.1 Auto Mode

Auto mode is the default setting of RSB-4210 VGA/HDMI output. In auto mode, the display interface 0 signal (DI0) has already been modified to output 720P60 (1280 x 720 @ 60) in advance. As illustrated in Table 3-13, there are three default input resolution timing settings for HDMI and one for VGA for reference.

When connecting a HDMI panel with the board, the output resolution of the panel will be adjusted to the most optimal default setting automatically by CH7033B. (For example, if the panel supports 1080P as its max resolution, CH7033B will detect and adjust its output resolution to 1080P after connecting the panel with RSB-4210.)

When connecting a VGA panel with the board, the output resolution of the panel will be adjusted to 1024x768 output resolution no matter what the max resolution your VGA panel supports.

Table 3.1: Output Resolution of RSB-4210 Auto Mode

Interface	Resolution	Note
HDMI	1080P60,720P60,480P60	Auto detection
VGA	1024 x 768 @ 60	

3.9.2 Bypass Mode

Bypass mode is an output alternative that the output resolution will be determined by default timing settings of your panel. There are 44 built-in timings provided by Advantech on RSB-4210, you can choose either one of them to match the timing setting of your panel. (For example, if your panel supports UXGA60 as its max resolution, you may choose value "2".)

Table 3.2: 44 Built-in Timings of RSB-4210 Bypass Mode

Value	Name	Pixel Clock	Resolution
0	WUXGA60	154000	1920x1200@60P
1	UXGA60	162000	1600x1200@60P
2	1080P60	148500	1920x1080@60P
3	1080P50	148500	1920x1080@50P
4	1080I60	74250	1920x1080@60I
5	1080I50	74250	1920x1080@50I
6	WSXGA+60	119000	1680x1050@60P
7	SXGA+75	156000	1400x1050@75P
8	SXGA+60	101000	1400x1050@60P
9	SXGA85	157500	1280x1024@85P
10	SXGA75	135000	1280x1024@75P
11	SXGA60	108000	1280x1024@60P
12	SXGA50	75428	1280x1024@50P
13	1280x960P60	108000	1280x960@60P
14	1440x900P75	136750	1440x900@75P
15	1440x900RDC	88750	1440x900@60P
16	1440x900P60	106500	1440x900@60P
17	WXGA75	106500	1280x800@75P
18	WXGA60	71000	1280x800@60P
19	1366x768P60	76000	1366x768@60P
20	1366x768CTM	72350	1366x768@60P
21	1360x768P60	85500	1360x768@60P
22	1280x768P75	102250	1280x768@75P
23	1280x768RDC	68250	1280x768@60P
24	1280x768VESA	79500	1280x768@60P
25	1280x768TV	80120	1280x768@60P
26	XGA85	94500	1024x768@85P
27	XGA75	78750	1024x768@75P
28	XGA70	75000	1024x768@70P
29	XGA60	65000	1024x768@60P
30	720P60	74250	1280x720@60P
31	720P50	74250	1280x720@50P
32	WSVGA60	47360	1024x600@60P
33	WSVGA_YING	45000	1024x600@60P
34	SVGA85	56250	800x600@85P
35	SVGA75	49500	800x600@75P
36	SVGA60	40000	800x600@60P
37	PAL-TV	27000	720x576@50P
38	NTSC-TV	27000	720x480@60P
39	VGA85	36000	640x480@85P
40	VGA75	31500	640x480@75P
41	VGA72	31500	640x480@72P
42	VGA60	25200	640x480@60P

Table 3.2: 44 Built-in Timings of RSB-4210 Bypass Mode

43	720x400P85	35500	720x400@85P
44	640x400P85	31500	640x400@85P
255	Auto Mode		

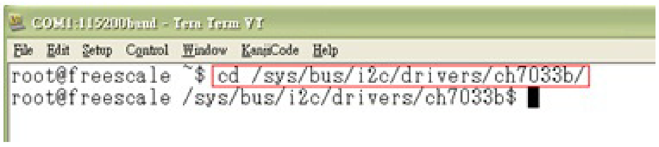
Furthermore, an auto parameter provided by Advantech can be set to decide which panel is the primary screen (VGA/HDMI or LVDS interface). As listed in Table 3-15, there are three kinds of auto parameters with different limitations, you can choose either one of them to meet your requirements.

Table 3.3: Auto Parameters

Auto Parameter	Description	Note
9	VGA/HDMI and LVDS are the same screen	This mode only supports 1080P60
19	VGA/HDMI is primary screen, LVDS is secondary screen	LVDS only supports 800x480.
23	LVDS is primary screen, VGA/HDMI is secondary screen	LVDS only supports 800x480.

To change RSB-4210 output to bypass mode (auto mode as default), please refer to the following steps:

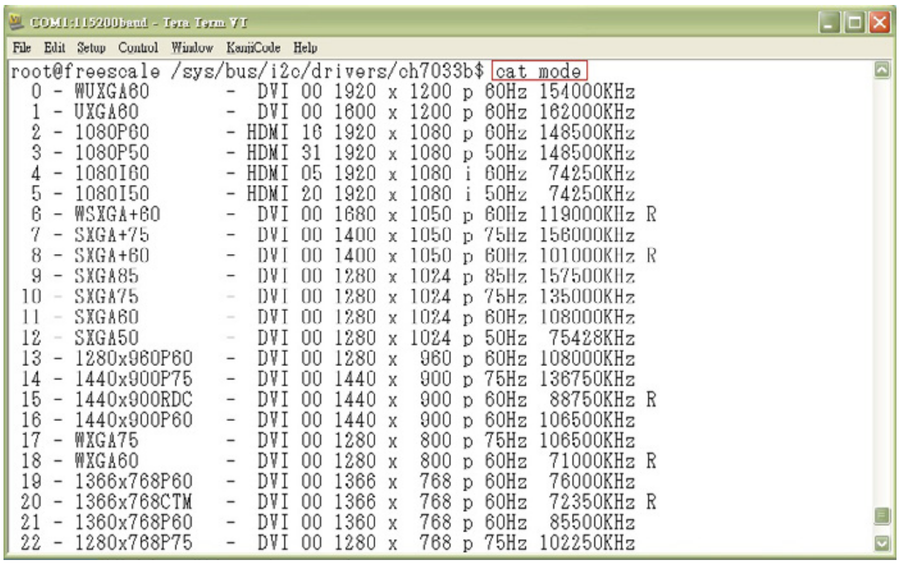
1. Type `#root` (login)
2. Type `# cd /sys/bus/i2c/drivers/ch7033b/`
   (Change directory to configure CH7033B)


COM1:115200baud - Tera Term VT
File Edit Setup Control Window KanjiCode Help

```
root@freescale ~$ cd /sys/bus/i2c/drivers/ch7033b/
root@freescale /sys/bus/i2c/drivers/ch7033b$
```

Figure 3.13 Change directory to configure CH7033B

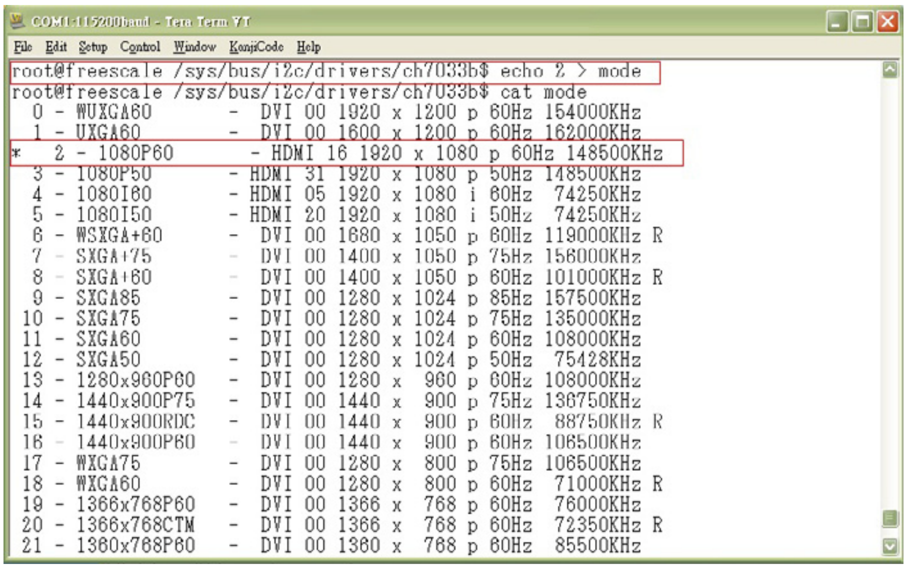
3. Type `# cat mode` (Display all built-in timings)


COM1:115200baud - Tera Term VT
File Edit Setup Control Window KanjiCode Help

```
root@freescale /sys/bus/i2c/drivers/ch7033b$ cat mode
  0 - WUXGA60        -  DVI 00 1920 x 1200 p 60Hz 154000KHz
  1 - UXGA60         -  DVI 00 1600 x 1200 p 60Hz 162000KHz
  2 - 1080P60        - HDMI 16 1920 x 1080 p 60Hz 148500KHz
  3 - 1080P50        - HDMI 31 1920 x 1080 p 50Hz 148500KHz
  4 - 1080I60        - HDMI 05 1920 x 1080 i 60Hz  74250KHz
  5 - 1080I50        - HDMI 20 1920 x 1080 i 50Hz  74250KHz
  6 - WSXGA+60       -  DVI 00 1680 x 1050 p 60Hz 119000KHz R
  7 - SXGA+75        -  DVI 00 1400 x 1050 p 75Hz 156000KHz
  8 - SXGA+60        -  DVI 00 1400 x 1050 p 60Hz 101000KHz R
  9 - SXGA85         -  DVI 00 1280 x 1024 p 85Hz 157500KHz
 10 - SXGA75         -  DVI 00 1280 x 1024 p 75Hz 135000KHz
 11 - SXGA60         -  DVI 00 1280 x 1024 p 60Hz 108000KHz
 12 - SXGA50         -  DVI 00 1280 x 1024 p 50Hz  75428KHz
 13 - 1280x960P60    -  DVI 00 1280 x  960 p 60Hz 108000KHz
 14 - 1440x900P75    -  DVI 00 1440 x  900 p 75Hz 136750KHz
 15 - 1440x900RDC    -  DVI 00 1440 x  900 p 60Hz  88750KHz R
 16 - 1440x900P60    -  DVI 00 1440 x  900 p 60Hz 106500KHz
 17 - WXGA75         -  DVI 00 1280 x  800 p 75Hz 106500KHz
 18 - WXGA60         -  DVI 00 1280 x  800 p 60Hz  71000KHz R
 19 - 1366x768P60    -  DVI 00 1366 x  768 p 60Hz  76000KHz
 20 - 1366x768CTM    -  DVI 00 1366 x  768 p 60Hz  72350KHz R
 21 - 1360x768P60    -  DVI 00 1360 x  768 p 60Hz  85500KHz
 22 - 1280x768P75    -  DVI 00 1280 x  768 p 75Hz 102250KHz
```

Figure 3.14 Display all built-in timing settings

4. Type `# echo 2 > mode` (Configure bypass mode)



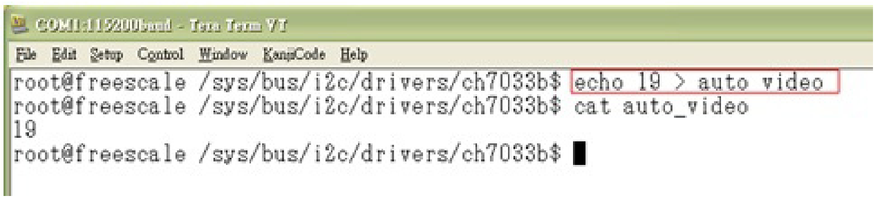
```
root@freescale /sys/bus/i2c/drivers/ch7033b$ echo 2 > mode
root@freescale /sys/bus/i2c/drivers/ch7033b$ cat mode
  0 - WUXGA60       -  DVI 00 1920 x 1200 p 60Hz 154000KHz
  1 - UXGA60        -  DVI 00 1600 x 1200 p 60Hz 162000KHz
*   2 - 1080P60       - HDMI 16 1920 x 1080 p 60Hz 148500KHz
  3 - 1080P50       - HDMI 31 1920 x 1080 p 50Hz 148500KHz
  4 - 1080I60       - HDMI 05 1920 x 1080 i 60Hz  74250KHz
  5 - 1080I50       - HDMI 20 1920 x 1080 i 50Hz  74250KHz
  6 - WSXGA+60      -  DVI 00 1680 x 1050 p 60Hz 119000KHz R
  7 - SXGA+75       -  DVI 00 1400 x 1050 p 75Hz 156000KHz
  8 - SXGA+60       -  DVI 00 1400 x 1050 p 60Hz 101000KHz R
  9 - SXGA85        -  DVI 00 1280 x 1024 p 85Hz 157500KHz
 10 - SXGA75        -  DVI 00 1280 x 1024 p 75Hz 135000KHz
 11 - SXGA60        -  DVI 00 1280 x 1024 p 60Hz 108000KHz
 12 - SXGA50        -  DVI 00 1280 x 1024 p 50Hz  75428KHz
 13 - 1280x960P60   -  DVI 00 1280 x  960 p 60Hz 108000KHz
 14 - 1440x900P75   -  DVI 00 1440 x  900 p 75Hz 136750KHz
 15 - 1440x900RDC   -  DVI 00 1440 x  900 p 60Hz  88750KHz R
 16 - 1440x900P60   -  DVI 00 1440 x  900 p 60Hz 106500KHz
 17 - WXGA75        -  DVI 00 1280 x  800 p 75Hz 106500KHz
 18 - WXGA60        -  DVI 00 1280 x  800 p 60Hz  71000KHz R
 19 - 1366x768P60   -  DVI 00 1366 x  768 p 60Hz  76000KHz
 20 - 1366x768CTM   -  DVI 00 1366 x  768 p 60Hz  72350KHz R
 21 - 1360x768P60   -  DVI 00 1360 x  768 p 60Hz  85500KHz
```

COM1:115200baud - Tera Term VT
File Edit Setup Control Window KanjiCode Help

Figure 3.15 Bypass mode configuration

Note! *You can choose the value which corresponds with your panel resolution setting. Above is an example for 1920 x 1080p resolution.*

5. Type `# echo 19 > auto_video` (Use auto parameter function)



```
root@freescale /sys/bus/i2c/drivers/ch7033b$ echo 19 > auto_video
root@freescale /sys/bus/i2c/drivers/ch7033b$ cat auto_video
19
root@freescale /sys/bus/i2c/drivers/ch7033b$ █
```

COM1:115200baud - Tera Term VT
File Edit Setup Control Window KanjiCode Help

Figure 3.16 Auto parameter selection

Note! *You can choose the auto parameter corresponds with your requirement. Above is an example for VGA/HDMI as primary screen.*

6. Type `#reboot` (Restart the system)
7. Finish

3.10 GPIO mapping define on RSB4210

3.10.1 What is a GPIO?

General Purpose Input/Output (GPIO) is a generic pin on a chip whose behavior (including whether it is an input or output pin) can be controlled (programmed) through software. It is a flexible software-controlled digital signal. They are provided from many kinds of chip, and are familiar to Linux developers working with embedded and custom hardware. Each GPIO represents a bit connected to a particular pin. Board schematics show which external hardware connects to which GPIOs. Drivers can be written generically, so that board setup code passes such pin configuration data to drivers.

3.10.2 Paths in Sysfs

There are three kinds of entry in /sys/class/gpio:

- Control interfaces used to get userspace control over GPIOs;
- GPIOs themselves; and
- GPIO controllers ("gpio_chip" instances).

That's in addition to standard files including the "device" symlink. The control interfaces are write-only:

```
    /sys/class/gpio/


       "export" ... Userspace may ask the kernel to export con-
trol of
           a GPIO to userspace by writing its number to this
file.
           #echo 19 > export
Will create a "gpio19" node for GPIO #19, if that's not
requested by kernel code.


       "unexport" ... Reverses the effect of exporting to user-
space.
           "echo 19 > unexport"
Will remove a "gpio19" node exported using the "export" file.


GPIO signals have paths like /sys/class/gpio/gpio42/ (for GPIO
#42)
and have the following read/write attributes:

    /sys/class/gpio/gpioN/
```

"direction"	reads as either "in" or "out". This value may normally be written. Writing as "out" defaults to initializing the value as low. To ensure glitch free operation, values "low" and "high" may be written to configure the GPIO as an output with that initial value. Note that this attribute *will not exist* if the kernel doesn't support changing the direction of a GPIO, or it was exported by kernel code that didn't explicitly allow userspace to reconfigure this GPIO's direction.
"value"	reads as either 0 (low) or 1 (high). If the GPIOis configured as an output, this value may be written; any nonzero value is treated as high. If the pin can be configured as interrupt-generating interrupt and if it has been configured to generate interrupts (see the description of "edge"), you can poll(2) on that file and poll(2) will return whenever the interrupt was triggered. If you use poll(2), set the events POLLPRI and POLLERR. If you use select(2), set the file descriptor in exceptfds. After poll(2) returns, either lseek(2) to the beginning of the sysfs file and read the new value or close the file and re-open it to read the value.

"edge"	reads as either "none", "rising", "falling", or "both". Write these strings to select the signal edge(s) that will make poll(2) on the "value" file return. This file exists only if the pin can be configured as aninterrupt generating input pin.
"active_low"	reads as either 0 (false) or 1 (true). Write any nonzero value to invert the value attribute both for reading and writing. Existing and subsequent poll(2) support configuration via the edge attribute for "rising" and "falling" edges will follow this setting. GPIO controllers have paths like /sys/class/gpio/gpiochip42/ (for the controller implementing GPIOs starting at #42) and have the following read-only attributes:

/sys/class/gpio/gpiochipN/

"base" ... same as N, the first GPIO managed by the chip

"label" ... provided for diagnostics (not always unique)

"ngpio" ... how many GPIOs this manges (N to N + ngpio - 1)

Board documentation should in most cases cover what GPIOs are used for what purposes. However, those numbers are not always stable; GPIOs on a daughtercard might be different depending on the base board being used, or other cards in the stack. In such cases, you may need to use the gpiochip nodes (possibly in conjunction with schematics) to determine the correct GPIO number to use for a given signal.

Exporting from Kernel code

Kernel code can explicitly manage exports of GPIOs which have already been requested using gpio_request():

```
       /* export the GPIO to userspace */
       int gpio_export(unsigned gpio, bool direction_may_change);
       /* reverse gpio_export() */
       void gpio_unexport();
       /* create a sysfs link to an exported GPIO node */
       int gpio_export_link(struct device *dev, const char *name, unsigned gpio)
       /* change the polarity of a GPIO node in sysfs */
       int gpio_sysfs_set_active_low(unsigned gpio, int value);
```

After a kernel driver requests a GPIO, it may only be made available in the sysfs interface by gpio_export(). The driver can control whether the signal direction may change. This helps drivers prevent userspace code from accidentally clobbering important system state.

(More detail please reference "source/linux-2.6.35.3/Documentation/ gpio.txt")

3.10.3 GPIO Mapping Table

ROM-1210		RSB-4210	
Logical Number	**Physical Number**	**Logical Number**	**Physical Number**
1	149	1	176
2	148	2	148
3	147	3	147
4	33	4	33
5	175	5	224
6	176	6	225
7	226	7	226
8	227	8	227
9	228	9	228
10	229	10	229
11	230	11	230
12	231	12	231
13	232	13	232
14	233	14	233
15	234	15	234
16	235	16	235
17	236	17	236
18	237	18	237
19	238	19	238
20	239	20	239

3.11 Interface Device Reference Documentation

3.11.1 I2C

Usually, i2c devices are controlled by a kernel driver. But it is also possible to access all devices on an adapter from userspace, through the /dev interface. You need to load module i2c-dev for this. Each registered i2c adapter gets a number, counting from 0. You can examine /sys/class/i2c-dev/ to see what number corresponds to which adapter. Alternatively, you can run "i2cdetect -l" to obtain a formated list of all i2c adapters present on your system at a given time. i2cdetect is part of the i2c-tools package.

I2C device files are character device files with major device number 89 and a minor device number corresponding to the number assigned as explained above. They should be called "i2c-%d" (i2c-0, i2c-1, ..., i2c-10, ...). All 256 minor device numbers are reserved for i2c.

3.11.2 C example

To access an i2c adapter from a C program. The first thing to do is "#include <linux/i2c-dev.h>". Please note that there are two files named "i2c-dev.h" out there, one is distributed with the Linux kernel and is meant to be included from kernel driver code, the other one is distributed with i2c-tools and is meant to be included from user-space programs. You obviously want the second one here.

Now, you have to decide which adapter you want to access. You should inspect /sys/class/i2c-dev/ or run "i2cdetect -l" to decide this. Adapter numbers are assigned somewhat dynamically, so you cannot assume much about them. They can even change from one boot to the next.

Next thing, open the device file, as follows:

```
  int file;
  int adapter_nr = 2; /* probably dynamically determined */
  char filename[20];

  snprintf(filename, 19, "/dev/i2c-%d", adapter_nr);
  file = open(filename, O_RDWR);
  if (file < 0) {
     /* ERROR HANDLING; you can check errno to see what went
wrong */
    exit(1);
  }
```

When you have opened the device, you must specify with what device address you want to communicate:

```
  int addr = 0x40; /* The I2C address */

  if (ioctl(file, I2C_SLAVE, addr) < 0) {
     /* ERROR HANDLING; you can check errno to see what went
wrong */
    exit(1);
  }
```

Well, you are all set up now. You can now use SMBus commands or plain I2C to communicate with your device. SMBus commands are preferred if the device supports them. Both are illustrated below.

```
  __u8 register = 0x10; /* Device register to access */
  __s32 res;
  char buf[10];

/* Using SMBus commands */
  res = i2c_smbus_read_word_data(file, register);
  if (res < 0) {
    /* ERROR HANDLING: i2c transaction failed */
  } else {
    /* res contains the read word */
  }

  /* Using I2C Write, equivalent of
     i2c_smbus_write_word_data(file, register, 0x6543) */
  buf[0] = register;
  buf[1] = 0x43;
  buf[2] = 0x65;
  if (write(file, buf, 3) ! =3) {
    /* ERROR HANDLING: i2c transaction failed */
  }

  /* Using I2C Read, equivalent of i2c_smbus_read_byte(file) */
  if (read(file, buf, 1) != 1) {
    /* ERROR HANDLING: i2c transaction failed */
  } else {
    /* buf[0] contains the read byte */
  }
```

Note that only a subset of the I2C and SMBus protocols can be achieved by the means of read() and write() calls. In particular, so-called combined transactions (mixing read and write messages in the same transaction)

aren't supported. For this reason, this interface is almost never used by user-space programs.

Note! *Because of the use of inline functions, you *have* to use '-O' or some variation when you compile your program!*

3.11.2.1 Full interface description

The following IOCTLs are defined:

```
ioctl(file, I2C_SLAVE, long addr)
  Change slave address. The address is passed in the 7 lower
bits of the argument (except for 10 bit addresses, passed in
the 10 lower bits in this case).

ioctl(file, I2C_TENBIT, long select)
  Selects ten bit addresses if select not equals 0, selects
normal 7 bit addresses if select equals 0. Default 0.  This
request is only valid if the adapter has I2C_FUNC_10BIT_ADDR.

ioctl(file, I2C_PEC, long select)
```

Selects SMBus PEC (packet error checking) generation and verification if select not equals 0, disables if select equals 0. Default 0. Used only for SMBus transactions. This request only has an effect if the the adapter has I2C_FUNC_SMBUS_PEC; it is still safe if not, it just doesn't have any effect.

```
ioctl(file, I2C_FUNCS, unsigned long *funcs)
Gets the adapter functionality and puts it in *funcs.

ioctl(file, I2C_RDWR, struct i2c_rdwr_ioctl_data *msgset)
```

```
Do combined read/write transaction without stop in between.
Only valid if the adapter has I2C_FUNC_I2C.  The argument is a
pointer to a

  struct i2c_rdwr_ioctl_data {
      struct i2c_msg *msgs;  /* ptr to array of simple messages
*/
      int nmsgs;             /* number of messages to exchange
*/
  }
```

The msgs[] themselves contain further pointers into data buffers. The function will write or read data to or from that buffers depending on whether the I2C_M_RD flag is set in a particular message or not. The slave address and whether to use ten bit address mode has to be set in each message, overriding the values set with the above ioctl's.

```
ioctl(file, I2C_SMBUS, struct i2c_smbus_ioctl_data *args)
   Not meant to be called  directly; instead, use the access
functions
  below.
```

You can do plain i2c transactions by using read(2) and write(2) calls. You do not need to pass the address byte; instead, set it through ioctl I2C_SLAVE before you try to access the device.

You can do SMBus level transactions (see documentation file smbus-protocol for details) through the following functions:

```
  __s32 i2c_smbus_write_quick(int file, __u8 value);
  __s32 i2c_smbus_read_byte(int file);
  __s32 i2c_smbus_write_byte(int file, __u8 value);
  __s32 i2c_smbus_read_byte_data(int file, __u8 command);
  __s32 i2c_smbus_write_byte_data(int file, __u8 command, __u8 value);
  __s32 i2c_smbus_read_word_data(int file, __u8 command);
  __s32 i2c_smbus_write_word_data(int file, __u8 command, __u16 value);
  __s32 i2c_smbus_process_call(int file, __u8 command, __u16 value);
  __s32 i2c_smbus_read_block_data(int file, __u8 command, __u8 *values);
  __s32 i2c_smbus_write_block_data(int file, __u8 command, __u8 length, __u8 *val-
ues);
```

All these transactions return -1 on failure; you can read errno to see what happened. The 'write' transactions return 0 on success; the 'read' transactions return the read value, except for read_block, which returns the number of values read. The block buffers need not be longer than 32 bytes.

The above functions are all inline functions, that resolve to calls to the i2c_smbus_access function, that on its turn calls a specific ioctl with the data in a specific format. Read the source code if you want to know what happens behind the screens.

3.11.2.2 Implementation details

For the interested, here's the code flow which happens inside the kernel when you use the /dev interface to I2C:

1. Your program opens /dev/i2c-N and calls ioctl() on it, as described in section "C example" above.
2. These open() and ioctl() calls are handled by the i2c-dev kernel driver: see i2c-dev.c:i2cdev_open() and i2c-dev.c:i2cdev_ioctl(), respectively. You can think of i2c-dev as a generic I2C chip driver that can be programmed from user-space.
3. Some ioctl() calls are for administrative tasks and are handled by i2c-dev directly. Examples include I2C_SLAVE (set the address of the device you want to access) and I2C_PEC (enable or disable SMBus error checking on future transactions.)
4. Other ioctl() calls are converted to in-kernel function calls by i2c-dev. Examples include I2C_FUNCS, which queries the I2C adapter functionality using i2c.h:i2c_get_functionality(), and I2C_SMBUS, which performs an SMBus transaction using i2c-core.c:i2c_smbus_xfer().
   The i2c-dev driver is responsible for checking all the parameters that come from user-space for validity. After this point, there is no difference between these calls that came from user-space through i2c-dev and calls that would have been performed by kernel I2C chip drivers directly. This means that I2C bus drivers don't need to implement anything special to support access from user-space.
5. These i2c-core.c/i2c.h functions are wrappers to the actual implementation of your I2C bus driver. Each adapter must declare callback functions implementing these standard calls. i2c.h:i2c_get_functionality() calls i2c_adapter.algo->functionality(), while i2c-core.c:i2c_smbus_xfer() calls either adapter.algo->smbus_xfer() if it is implemented, or if not, i2c-core.c:i2c_smbus_xfer_emulated() which in turn calls i2c_adapter.algo->master_xfer().

After your I2C bus driver has processed these requests, execution runs up the call chain, with almost no processing done, except by i2c-dev to package the returned data, if any, in suitable format for the ioctl.

More detail please reference "source/linux-2.6.35.3/Documentation/i2c/dev-interface"

3.11.3 UART

3.11.3.1 Driver Interface

open()	Called when a device is opened. May sleep
close()	Called when a device is closed. At the point of return from this call the driver must make no further ldisc calls of any kind. May sleep
write()	Called to write bytes to the device. May notsleep. May occur in parallel in special cases. Because this includes panic paths drivers generally shouldn't try and do clever locking here.
put_char()	Stuff a single character onto the queue. Thedriver is guaranteed following up calls to flush_chars.
flush_chars()	Ask the kernel to write put_char queue
write_room()	Return the number of characters tht can be stuffed into the port buffers without overflow (or less).The ldisc is responsible for being intelligent about multi-threading of write_room/write calls
ioctl()	Called when an ioctl may be for the driver

set_termios()	Called on termios change, serialized against itself by a semaphore. May sleep.
set_ldisc()	Notifier for discipline change. At the point this is done the discipline is not yet usable. Can now sleep (I think)
throttle()	Called by the ldisc to ask the driver to do flow control. Serialization including with unthrottle is the job of the ldisc layer.
unthrottle()	Called by the ldisc to ask the driver to stop flow control.
stop()	Ldisc notifier to the driver to stop output. As with throttle the serializations with start() are down to the ldisc layer.
start()	Ldisc notifier to the driver to start output.
hangup()	Ask the tty driver to cause a hangup initiated from the host side. [Can sleep ??]
break_ctl()-	Send RS232 break. Can sleep. Can get called in parallel, driver must serialize (for now), and with write calls.
wait_until_sent()	Wait for characters to exit the hardware queue of the driver. Can sleep
send_xchar()	Send XON/XOFF and if possible jump the queue with it in order to get fast flow control responses.

3.11.3.2 Line Discipline Methods

(A). Flags

Line discipline methods have access to tty->flags field containing the following interesting flags:

TTY_THROTTLED	Driver input is throttled. The ldisc should call tty->driver->unthrottle() in order to resume reception when it is ready to process more data.
TTY_DO_WRITE_WAKEUP	If set, causes the driver to call the ldisc's write_wakeup() method in order to resume transmission when it can accept more data to transmit.
TTY_IO_ERROR	If set, causes all subsequent userspace read/write calls on the tty to fail, returning -EIO.
TTY_OTHER_CLOSED	Device is a pty and the other side has closed.
TTY_NO_WRITE_SPLIT	Prevent driver from splitting up writes into smaller chunks.

(B). Locking

Callers to the line discipline functions from the tty layer are required to take line discipline locks. The same is true of calls from the driver side but not yet enforced.

Three calls are now provided

```
        ldisc = tty_ldisc_ref(tty);
```

Takes a handle to the line discipline in the tty and returns it. If no ldisc is currently attached or the ldisc is being closed and re-opened at this point then NULL is returned. While this handle is held the ldisc will not change or go away.

```
        tty_ldisc_deref(ldisc)
```

Returns the ldisc reference and allows the ldisc to be closed. Returning the reference takes away your right to call the ldisc functions until you take a new reference.

```
ldisc = tty_ldisc_ref_wait(tty);
```

Performs the same function as tty_ldisc_ref except that it will wait for an ldisc change to complete and then return a reference to the new ldisc.

While these functions are slightly slower than the old code they should have minimal impact as most receive logic uses the flip buffers and they only need to take a reference when they push bits up through the driver.

Caution! *The ldisc->open(), ldisc->close() and driver->set_ldisc functions are called with the ldisc unavailable. Thus tty_ldisc_ref will fail in this situation if used within these functions. Ldisc and driver code calling its own functions must be careful in this case.*

3.11.3.3 RS422/RS485 Tips

Transmit RS422/RS458 as soon as setting GPIO 61/62 "high". Receive RS485 as soon as setting GPIO 61/63 low.

3.11.3.4 Software Tips

This program is free software; you can redistribute it and/or modify it under the terms of the GNU General Public License as published by the Free Software Foundation; either version 2 of the License, or (at your option) any later version.

This program is distributed in the hope that it will be useful, but WITHOUT ANY WARRANTY; without even the implied warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the GNU General Public License for more details.

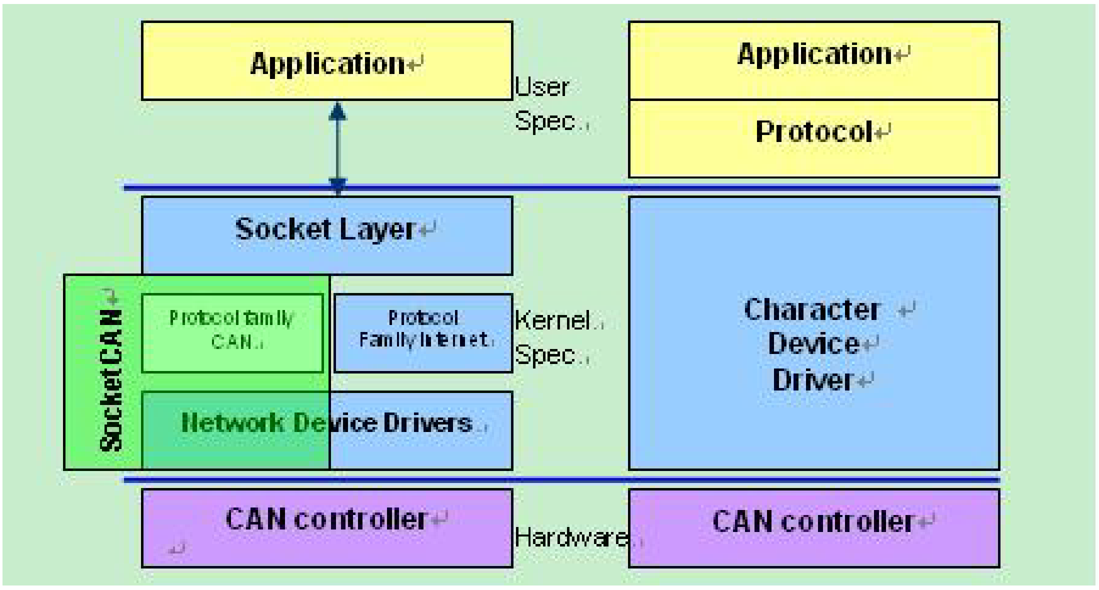
```
#include <stdarg.h>
#include <termio.h>
#include <sys/timeb.h>
#include <pthread.h>
#include <stdio.h>
#include <string.h>
#include <unistd.h>
#include <fcntl.h>
#include <signal.h>
#include <errno.h>
#include <stdlib.h>


#define DEFAULT_RATE 115200;

unsigned int get_time(void)
{
    struct timeb tb;
    unsigned int realNow;
    ( void ) ftime( &tb );

    realNow = (unsigned int )(((tb.time%4290) * 1000000 ) + (
tb.millitm * 1000 ));

    return(realNow);
}

static speed_t baudrate_map(unsigned long b)
{
    speed_t retval;

    switch(b)
    {
        case 110:
            retval = B110;
            break;

        case 300:
            retval = B300;
            break;

        case 1200:
            retval = B1200;
            break;

        case 2400:
            retval = B2400;
            break;

        case 4800:
            retval = B4800;
            break;

        case 9600:
            retval = B9600;
            break;

        case 19200:
            retval = B19200;
            break;

        case 38400:
            retval = B38400;
            break;
        case 57600:
            retval = B57600;
            break;

        case 115200:
            retval = B115200;
            break;

#ifdef B230400
        case 230400:
            retval = B230400;
            break;
#endif

#ifdef B460800
        case 460800:
            retval = B460800;
            break;
#endif

#ifdef B500000
        case 500000:
            retval = B500000;
            break;
#endif

#ifdef B576000
        case 576000:
            retval = B576000;
            break;
#endif

#ifdef B921600
        case 921600:
            retval = B921600;
            break;
#endif

#ifdef B1000000
        case 1000000:
            retval = B1000000;
            break;
#endif

#ifdef B1152000
```

```
        case 1152000:
            retval = B1152000;
            break;
#endif

#ifdef B1500000
        case 1500000:
            retval = B1500000;
            break;
#endif

#ifdef B2000000
        case 2000000:
            retval = B2000000;
            break;
#endif

#ifdef B2500000
        case 2500000:
            retval = B2500000;
            break;
#endif

#ifdef B3000000
        case 3000000:
            retval = B3000000;
            break;
#endif

#ifdef B3500000
        case 3500000:
            retval = B3500000;
            break;
#endif

#ifdef B4000000
        case 4000000:
            retval = B4000000;
            break;
#endif

        default:
            retval = 0;
            break;
    }
    return(retval);
}

int trun, rrun;
int fd;
int size = 10000;
unsigned int tcount, rcount;
FILE *furead;

void *Uartsend(void * threadParameter)
{
       int *tx;
       double speed;
       double time;
       tcount = 0;

       tx = malloc(size);
       memset(tx, 0x0f, size);
       while(trun) {
            sleep(1);
            tx[0] = 0x55;
            time = get_time();
            write(fd, tx, size);
            time = get_time() - time;
            speed = size * 8 / (time/1000000);
            tcount += size;
            printf("sent  %d  bytes  with  speed  %fbps\n",  size,
speed);
       }
       free(tx);
       return 0;
}

void *Uartread(void * threadParameter)
{
       char *rx;
       int iores, iocount;
       rcount = 0;

       while(rrun) {
            iocount = 0;
            iores = ioctl(fd, FIONREAD, &iocount);
            if(!iocount)
                 continue;
                  rx = malloc(iocount);
            /* Read in and wrap around the list */
                 iores = read(fd, rx, iocount);
            rcount += iores;
            fwrite(rx, 1, iores, furead);
            free(rx);
        }
        return 0;
}

static void print_usage(const char *pname)
{
        printf("Usage: %s device [-S] [-O] [-E] [-HW] [-B bau-
drate]"
                "\n\t'-S' for 2 stop bit"
                "\n\t'-O' for PARODD "
                "\n\t'-E' for PARENB"
                "\n\t'-HW' for HW flow control enable"
                  "\n\t'-B baudrate' for different baudrate\n",
pname);

}

int main(int argc, char *argv[])
{
        int i, ret;
        struct termios options;
        unsigned long baudrate = DEFAULT_RATE;
        char c = 0;
        pthread_t p_Uartsend, p_Uartread;
        void *thread_res;

        if (argc < 2 || strncmp(argv[1], "/dev/ttymxc", 11)) {
            print_usage(argv[0]);
            return -1;
        }

        fd = open(argv[1], O_RDWR | O_NOCTTY);

        if (fd == -1) {
            printf("open_port: Unable to open serial port - %s",
argv[1]);
            return -1;
        }

        fcntl(fd, F_SETFL, 0);
        tcgetattr(fd, &options);
        options.c_cflag &= ~CSTOPB;
        options.c_cflag &= ~CSIZE;
        options.c_cflag |= PARENB;
        options.c_cflag &= ~PARODD;
        options.c_cflag |= CS8;
        options.c_cflag &= ~CRTSCTS;

        options.c_lflag &= ~(ICANON | IEXTEN | ISIG | ECHO);
        options.c_oflag &= ~OPOST;
        options.c_iflag &= ~(ICRNL | INPCK | ISTRIP | IXON |
BRKINT );

        options.c_cc[VMIN] = 1;
        options.c_cc[VTIME] = 0;

        options.c_cflag |= (CLOCAL | CREAD);
        for(i = 2; i < argc; i++) {
            if (!strcmp(argv[i], "-S")) {
                options.c_cflag |= CSTOPB;
                continue;
            }
            if (!strcmp(argv[i], "-O")) {
                options.c_cflag |= PARODD;
                options.c_cflag &= ~PARENB;
                continue;
            }
            if (!strcmp(argv[i], "-E")) {
                options.c_cflag &= ~PARODD;
                options.c_cflag |= PARENB;
                continue;
            }
            if (!strcmp(argv[i], "-HW")) {
                options.c_cflag |= CRTSCTS;
                continue;
            }
            if (!strcmp(argv[i], "-B")) {
                i++;
                baudrate = atoi(argv[i]);
                if(!baudrate_map(baudrate))
                    baudrate = DEFAULT_RATE;
                continue;
            }
        }
        if(baudrate) {
            cfsetispeed(&options, baudrate_map(baudrate));
            cfsetospeed(&options, baudrate_map(baudrate));
        }
        tcsetattr(fd, TCSANOW, &options);
        printf("UART %lu, %dbit, %dstop, %s, HW flow %s\n", bau-
drate, 8,
                (options.c_cflag & CSTOPB) ? 2 : 1,
                (options.c_cflag & PARODD) ? "PARODD" : "PARENB",
                 (options.c_cflag & CRTSCTS) ? "enabled" : "dis-
abled");

        trun = 1;
        rrun = 1;
        furead = fopen("uart_read.txt","wb");

        ret = pthread_create(&p_Uartsend, NULL, Uartsend, NULL);
        if(ret < 0)
            goto error;
        ret = pthread_create(&p_Uartread, NULL, Uartread, NULL);
        if(ret < 0) {
            ret = pthread_join(p_Uartsend, &thread_res);
            goto error;
        }

        printf("test begin, press 'c' to exit\n");

        while(c != 'c'){
            c = getchar();
        }

        trun = 0;
        ret = pthread_join(p_Uartsend, &thread_res);
        if(ret < 0)
            printf("fail to stop Uartsend thread\n");
        printf("tcount=%d\n",tcount);
        i = 5;
        while((tcount > rcount) && i) {
            i--;
            sleep(1);
        }
        rrun = 0;
        ret = pthread_join(p_Uartread, &thread_res);
        if(ret < 0)
            printf("fail to stop Uartread thread\n");
        printf("rcount=%d\n",rcount);
error:
        fclose(furead);
        close(fd);
        printf("test exit\n");

        return 0;
}
```

(More detail please reference "source/linux-2.6.35.3/Documentation/serial/tty.txt")

3.11.4 CAN bus

CAN bus is a set of open source CAN drivers and a networking stack contributed by Volkswagen Research to the Linux kernel. Formerly known as `Low Level CAN Framework (LLCF).`



Typical CAN communication layers. With SocketCAN (left) or conventional (right).

Traditional CAN drivers for Linux are based on the model of character devices. Typically they only allow sending to and receiving from the CAN controller. Conventional implementations of this class of device driver only allow a single process to access the device, which means that all other processes are blocked in the meantime. In addition, these drivers typically all differ slightly in the interface presented to the application, stifling portability. The SocketCAN concept on the other hand uses the model of network devices, which allows multiple applications to access one CAN device simultaneously. Also, a single application is able to access multiple CAN networks in parallel.

The application first sets up its access to the CAN interface by initialising a socket (much like in TCP/IP communications), then binding that socket to an interface (or all interfaces, if the application so desires). Once bound, the socket can then be used like a UDP socket via read, write, etc...

The following is a simple (incomplete) example, that sends a packet, then reads back a packet using the raw interface. It is based on the notes documented in the Linux Kernel.

```
#include <can_config.h>

#include <getopt.h>
#include <libgen.h>
```

```
#include <signal.h>
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <unistd.h>
#include <limits.h>

#include <net/if.h>

#include <sys/ioctl.h>
#include <sys/socket.h>
#include <sys/types.h>
#include <sys/uio.h>
#include <time.h>
#include <sys/time.h>
#include <linux/can.h>
#include <linux/can/raw.h>

extern int optind, opterr, optopt;

static void print_usage(char *prg)
{
      fprintf(stderr,
           "Usage: %s [<can-interface>] [Options] <can-msg>\n"
           "<can-msg> can consist of up to 8 bytes given as a
space separated list\n"
           "Options:\n"
           " -i, --identifier=IDCAN Identifier (default = 1)\n"
           " -r  --rtrsend remote request\n"
           " -e  --extendedsend extended frame\n"
           " -f, --family=FAMILYProtocol    family    (default
PF_CAN = %d)\n"
           " -t, --type=TYPESocket  type,  see  man  2  socket
(default SOCK_RAW = %d)\n"
           " -p, --protocol=PROTOCAN protocol (default CAN_RAW
= %d)\n"
           " -l         send message infinite times\n"
           "     --loop=COUNTsend message COUNT times\n"
           " -v, --verbosebe verbose\n"
           " -h, --helpthis help\n"
           " -R, --relayRelay Packet\n"
           "     --versionprint   version   information   and
exit\n",
           prg, PF_CAN, SOCK_RAW, CAN_RAW);
}
```

```
enum {
            VERSION_OPTION = CHAR_MAX + 1,
};
void sigalrm_fn(int sig)
{
       printf("CAN Bus Error\n");

       exit(1);
}
int main(int argc, char **argv)
{
       struct can_frame frame = {
            .can_id = 1,
       };
       struct ifreq ifr;
       struct sockaddr_can addr;
       char *interface;
       int family = PF_CAN, type = SOCK_RAW, proto = CAN_RAW;
       int loopcount = 1, infinite = 0;
       int s, opt, ret, i, rtr = 0, extended = 0,Relay=0;
       int verbose = 0;
       unsigned char test_pattern[8];
       struct option long_options[] = {
            { "help",no_argument,0, 'h' },
            { "identifier",required_argument,0, 'i' },
            { "rtr",no_argument,0, 'r' },
            { "extended",no_argument,0, 'e' },
            { "family",required_argument,0, 'f' },
            { "protocol",required_argument,0, 'p' },
            { "type",required_argument,0, 't' },
            { "version",no_argument,0, VERSION_OPTION},
            { "verbose",no_argument,0, 'v'},
            { "loop",required_argument,0, 'l'},
            { "relay",no_argument,0, 'R'},
            { 0,     0,            0, 0 },
       };

       while ((opt = getopt_long(argc, argv, "hf:t:p:vi:lreR",
long_options, NULL)) != -1) {
            switch (opt) {
            case 'h':
                 print_usage(basename(argv[0]));
                 exit(0);

            case 'f':
                 family = strtoul(optarg, NULL, 0);
```

```
                        break;

                case 't':
                        type = strtoul(optarg, NULL, 0);
                        break;

                case 'p':
                        proto = strtoul(optarg, NULL, 0);
                        break;

                case 'v':
                        verbose = 1;
                        break;

                case 'l':
                        if (optarg)
                                loopcount = strtoul(optarg, NULL, 0);
                        else
                                infinite = 1;
                        break;
                case 'i':
                        frame.can_id = strtoul(optarg, NULL, 0);
                        break;

                case 'r':
                        rtr = 1;
                        break;

                case 'e':
                        extended = 1;
                        break;
                case 'R':
                        Relay=1;
                        break;
                case VERSION_OPTION:
                        printf("cansend %s\n", VERSION);
                        exit(0);

                default:
                        fprintf(stderr, "Unknown option %c\n", opt);
                        break;
                }
        }

        if (optind == argc) {
          print_usage(basename(argv[0]));
          exit(0);
      }

      if (argv[optind] == NULL) {
          fprintf(stderr, "No Interface supplied\n");
          exit(-1);
      }
      interface = argv[optind];

      printf("interface = %s, family = %d, type = %d, proto =
%d\n",
             interface, family, type, proto);

      s = socket(family, type, proto);
      if (s < 0) {
          perror("socket");
          return 1;
      }

      addr.can_family = family;
      strcpy(ifr.ifr_name, interface);
      if (ioctl(s, SIOCGIFINDEX, &ifr)) {
          perror("ioctl");
          return 1;
      }
      addr.can_ifindex = ifr.ifr_ifindex;

      if (bind(s, (struct sockaddr *)&addr, sizeof(addr)) < 0)
{
          perror("bind");
          return 1;
      }
      /*set alarm to sigalrm_fm*/
      signal(SIGALRM, sigalrm_fn);

      srand(time(NULL));


      if (extended) {
          frame.can_id &= CAN_EFF_MASK;
          frame.can_id |= CAN_EFF_FLAG;
      } else {
          frame.can_id &= CAN_SFF_MASK;
      }
```

```
    if (rtr)
        frame.can_id |= CAN_RTR_FLAG;

    if (verbose) {
        printf("id: %d ", frame.can_id);
        printf("dlc: %d\n", frame.can_dlc);
        for (i = 0; i < frame.can_dlc; i++)
            printf("0x%02x ", frame.data[i]);
        printf("\n");
    }

    if(!Relay)
    {
        /*set 10 seconds to alarm */
        alarm(10);
        while (infinite || loopcount--) {

            for (i= 0 ;i<8;i++)
//              test_pattern[i]=random()%255;
                test_pattern[i]=0xFF;

            printf("Send Data :");
            for (i = 0; i < 8; i++) {
                printf("%d ",test_pattern[i]);
                frame.data[i] = test_pattern[i];
            }
            printf("\n");

            frame.can_dlc = 8;

            ret    =    write(s,    &frame,    sizeof(struct
can_frame));
            if (ret == -1) {
                perror("write");
                break;
            }
            /*clear buffer*/
            for (i = 0; i < 8; i++) {
                frame.data[i] = 0;
            }
            /* receice relay packet*/
            if ((read(s, &frame, sizeof(struct can_frame)))
< 0) {
                perror("read");
                return 1;
            } else {
```

```
                        printf("Receive data: ");
                        for(i =0; i<8 ;i++)
                        {
                            printf("%d ",frame.data[i]);
                            if(frame.data[i] != test_pattern[i])
                            {
                                printf("CAN Bus Error\n");
                                return 1;
                            }
                        }
                        printf("\n");
                    }
                }
            }
            else /*relay packet*/
            {
                int nBytes;
                while(1)
                {
                    if     ((nBytes=read(s,&frame,     sizeof(struct
        can_frame))) < 0) {
                        perror("read");
                        return 1;
                    } else {
                        printf("Receive data: ");
                        for(i=0;i<8;i++)
                            printf("%d ",frame.data[i]);
                        printf("\n");

                        write(s, &frame, sizeof(struct can_frame));
                    }
                }
            }
            close(s);
            return 0;
        }
```

(More detail please reference "source/linux-2.6.35.3/Documentation/networking/can.txt")

3.11.5 SD card /iNand /USB Disk/SATA Disk

SD-Cards, iNand, USB, and SATA Mass Storage devices are not mounted automatically in Linux systems. In order to access them, they have to be mounted manually from the console, using their devices nodes. The SD Card and iNand can be found under /dev/mmcblk0 and /dev/mmcblk1. its single partitions are located under /dev/mmcblk0pX with X being a positive number. The USB and SATA mass storage devices can be found under /dev/sdX with X=a..z, its single partitions under /dev/sdXY with Y being a positive number as table below:

SD card	`/dev/mmcblk1`
iNand	`/dev/mmcblk0`
USB Disk	`/dev/sdx`
SATA Disk	`/dev/sdx`

You can use open/close/write/read functions to control this storage.

3.11.6 LAN

Refer to Socket Programming (http://www.tenouk.com/cnlinuxsockettutorials.html)

3.11.7 RTC

Because Linux supports many non-ACPI and non-PC platforms, some of which have more than one RTC style clock, it needed a more portable solution than expecting a single battery-backed MC146818 clone on every system. Accordingly, a new "RTC Class" framework has been defined. It offers three different userspace interfaces:

* **/dev/rtcN** ... much the same as the older /dev/rtc interface

***/sys/class/rtc/rtcN**...sysfs attributes support readonly access to some RTC attributes.

* **/proc/driver/rtc** ... the first RTC (rtc0) may expose itself using a procfs interface.

More information is (currently) shown here than through sysfs.

The RTC Class framework supports a wide variety of RTCs, ranging from those integrated into embeddable system-on-chip (SOC) processors to discrete chips using I2C, SPI, or some other bus to communicate with the host CPU. There's even support for PC-style RTCs ... including the features exposed on newer PCs through ACPI.

The new framework also removes the "one RTC per system" restriction. For example, maybe the low-power battery-backed RTC is a discrete I2C chip, but a high functionality RTC is integrated into the SOC. That system might read the system clock from the discrete RTC, but use the integrated one for all other tasks, because of its greater functionality.

3.11.7.1 SYSFS INTERFACE

The sysfs interface under /sys/class/rtc/rtcN provides access to various rtc attributes without requiring the use of ioctls. All dates and times are in the RTC's timezone, rather than in system time.

date:	RTC-provided date
hctosys:	1 if the RTC provided the system time at boot via the CONFIG_RTC_HCTOSYS kernel option, 0 otherwise
max_user_freq:	The maximum interrupt rate an unprivileged user may request from this RTC.
name:	The name of the RTC corresponding to this sysfs directory
since_epoch:	The number of seconds since the epoch according to the RTC
time:	RTC-provided time

wakealarm:	The time at which the clock will generate a system wakeup event. This is a one shot wakeup event, so must be reset after wake if a daily wakeup is required. Format is either seconds since the epoch or, if there's a leading +, seconds in the future.

IOCTL INTERFACE

The ioctl() calls supported by /dev/rtc are also supported by the RTC class framework. However, because the chips and systems are not standardized, some PC/AT functionality might not be provided. And in the same way, some newer features -- including those enabled by ACPI -- are exposed by the RTC class framework, but can't be supported by the older driver.

* RTC_RD_TIME, RTC_SET_TIME ... every RTC supports at least reading time, returning the result as a Gregorian calendar date and 24 hour wall clock time. To be most useful, this time may also be updated.

* RTC_AIE_ON, RTC_AIE_OFF, RTC_ALM_SET, RTC_ALM_READ ... when the RTC is connected to an IRQ line, it can often issue an alarm IRQ up to 24 hours in the future. (Use RTC_WKALM_* by preference.)

* RTC_WKALM_SET, RTC_WKALM_RD ... RTCs that can issue alarms beyond the next 24 hours use a slightly more powerful API, which supports setting the longer alarm time and enabling its IRQ using a single request (using the same model as EFI firmware).

* RTC_UIE_ON, RTC_UIE_OFF ... if the RTC offers IRQs, it probably also offers update IRQs whenever the "seconds" counter changes. If needed, the RTC framework can emulate this mechanism.

* RTC_PIE_ON, RTC_PIE_OFF, RTC_IRQP_SET, RTC_IRQP_READ ... another feature often accessible with an IRQ line is a periodic IRQ, issued at settable frequencies (usually 2^N Hz).

In many cases, the RTC alarm can be a system wake event, used to force Linux out of a low power sleep state (or hibernation) back to a fully operational state. For example, a system could enter a deep power saving state until it's time to execute some scheduled tasks.

Note that many of these ioctls need not actually be implemented by your driver. The common rtc-dev interface handles many of these nicely if your driver returns ENOIOCTLCMD. Some common examples:

* RTC_RD_TIME, RTC_SET_TIME: the read_time/set_time functions will be called with appropriate values.

* RTC_ALM_SET, RTC_ALM_READ, RTC_WKALM_SET, RTC_WKALM_RD: the set_alarm/read_alarm functions will be called.

* RTC_IRQP_SET, RTC_IRQP_READ: the irq_set_freq function will be called to set the frequency while the framework will handle the read for you since the frequency is stored in the irq_freq member of the rtc_device structure. Your driver needs to initialize the irq_freq member during init. Make sure you check the requested frequency is in range of your hardware in the irq_set_freq function. If it isn't, return -EINVAL. If you cannot actually change the frequency, do not define irq_set_freq.

* RTC_PIE_ON, RTC_PIE_OFF: the irq_set_state function will be called.

If all else fails, check out the rtc-test.c driver!

```
/*****************************************************
/* Real Time Clock Driver Test/Example Program
/* Compile with:*gcc -s -Wall -Wstrict-prototypes rtctest.c -o rtctest
/* Released under the GNU General Public License, version 2,
/* included herein by reference.
/* *****************************************************/

#include <stdio.h>
#include <linux/rtc.h>
#include <sys/ioctl.h>
#include <sys/time.h>
#include <sys/types.h>
#include <fcntl.h>
#include <unistd.h>
#include <stdlib.h>
#include <errno.h>


/*
 * This expects the new RTC class driver framework, working
with
 * clocks that will often not be clones of what the PC-AT had.
 * Use the command line to specify another RTC if you need one.
 */
static const char default_rtc[] = "/dev/rtc0";


int main(int argc, char **argv)
{
        int i, fd, retval, irqcount = 0;
        unsigned long tmp, data;
        struct rtc_time rtc_tm;
        const char *rtc = default_rtc;

        switch (argc) {
```

```
        case 2:
            rtc = argv[1];
            /* FALLTHROUGH */
        case 1:
            break;
        default:
            fprintf(stderr, "usage:  rtctest [rtcdev]\n");
            return 1;
        }

        fd = open(rtc, O_RDONLY);

        if (fd ==  -1) {
            perror(rtc);
            exit(errno);
        }

        fprintf(stderr, "\n\t\t\tRTC Driver Test Example.\n\n");

        /* Turn on update interrupts (one per second) */
        retval = ioctl(fd, RTC_UIE_ON, 0);
        if (retval == -1) {
            if (errno == ENOTTY) {
                fprintf(stderr,
                    "\n...Update IRQs not supported.\n");
                goto test_READ;
            }
            perror("RTC_UIE_ON ioctl");
            exit(errno);
        }

        fprintf(stderr,  "Counting  5  update  (1/sec)  interrupts
from reading %s:",
                rtc);
        fflush(stderr);
        for (i=1; i<6; i++) {
            /* This read will block */
            retval = read(fd, &data, sizeof(unsigned long));
            if (retval == -1) {
                perror("read");
                exit(errno);
            }
            fprintf(stderr, " %d",i);
            fflush(stderr);
            irqcount++;
        }
        fprintf(stderr, "\nAgain, from using select(2) on /dev/
rtc:");
        fflush(stderr);
        for (i=1; i<6; i++) {
            struct timeval tv = {5, 0};     /* 5 second timeout
on select */
            fd_set readfds;

            FD_ZERO(&readfds);
            FD_SET(fd, &readfds);
            /* The select will wait until an RTC interrupt hap-
pens. */
            retval = select(fd+1, &readfds, NULL, NULL, &tv);
            if (retval == -1) {
                    perror("select");
                    exit(errno);
            }
            /* This read won't block unlike the select-less case
above. */
            retval = read(fd, &data, sizeof(unsigned long));
            if (retval == -1) {
                    perror("read");
                    exit(errno);
            }
            fprintf(stderr, " %d",i);
            fflush(stderr);
            irqcount++;
        }

        /* Turn off update interrupts */
        retval = ioctl(fd, RTC_UIE_OFF, 0);
        if (retval == -1) {
            perror("RTC_UIE_OFF ioctl");
            exit(errno);
        }

test_READ:
        /* Read the RTC time/date */
        retval = ioctl(fd, RTC_RD_TIME, &rtc_tm);
        if (retval == -1) {
            perror("RTC_RD_TIME ioctl");
            exit(errno);
        }

        fprintf(stderr, "\n\nCurrent RTC date/time is %d-%d-%d,
%02d:%02d:%02d.\n",
            rtc_tm.tm_mday, rtc_tm.tm_mon + 1, rtc_tm.tm_year +
  1900,
            rtc_tm.tm_hour, rtc_tm.tm_min, rtc_tm.tm_sec);

        /* Set the alarm to 5 sec in the future, and check for
  rollover */
        rtc_tm.tm_sec += 5;
        if (rtc_tm.tm_sec >= 60) {
            rtc_tm.tm_sec %= 60;
            rtc_tm.tm_min++;
        }
        if (rtc_tm.tm_min == 60) {
            rtc_tm.tm_min = 0;
            rtc_tm.tm_hour++;
        }
        if (rtc_tm.tm_hour == 24)
            rtc_tm.tm_hour = 0;

        retval = ioctl(fd, RTC_ALM_SET, &rtc_tm);
        if (retval == -1) {
            if (errno == ENOTTY) {
                fprintf(stderr,
                     "\n...Alarm IRQs not supported.\n");
                goto test_PIE;
            }
            perror("RTC_ALM_SET ioctl");
            exit(errno);
        }

        /* Read the current alarm settings */
        retval = ioctl(fd, RTC_ALM_READ, &rtc_tm);
        if (retval == -1) {
            perror("RTC_ALM_READ ioctl");
            exit(errno);
        }

        fprintf(stderr,    "Alarm    time    now    set    to
  %02d:%02d:%02d.\n",
            rtc_tm.tm_hour, rtc_tm.tm_min, rtc_tm.tm_sec);

        /* Enable alarm interrupts */
        retval = ioctl(fd, RTC_AIE_ON, 0);
        if (retval == -1) {
            perror("RTC_AIE_ON ioctl");
            exit(errno);
        }
```

```
       fprintf(stderr, "Waiting 5 seconds for alarm...");
       fflush(stderr);
       /* This blocks until the alarm ring causes an interrupt
*/
       retval = read(fd, &data, sizeof(unsigned long));
       if (retval == -1) {
           perror("read");
           exit(errno);
       }
       irqcount++;
       fprintf(stderr, " okay. Alarm rang.\n");

       /* Disable alarm interrupts */
       retval = ioctl(fd, RTC_AIE_OFF, 0);
       if (retval == -1) {
           perror("RTC_AIE_OFF ioctl");
           exit(errno);
       }

test_PIE:
       /* Read periodic IRQ rate */
       retval = ioctl(fd, RTC_IRQP_READ, &tmp);
       if (retval == -1) {
           /* not all RTCs support periodic IRQs */
           if (errno == ENOTTY) {
               fprintf(stderr, "\nNo periodic IRQ support\n");
               goto done;
           }
           perror("RTC_IRQP_READ ioctl");
           exit(errno);
       }
       fprintf(stderr, "\nPeriodic IRQ rate is %ldHz.\n", tmp);

       fprintf(stderr, "Counting 20 interrupts at:");
       fflush(stderr);

       /* The frequencies 128Hz, 256Hz, ... 8192Hz are only
allowed for root. */
       for (tmp=2; tmp<=64; tmp*=2) {

           retval = ioctl(fd, RTC_IRQP_SET, tmp);
           if (retval == -1) {
               /* not all RTCs can change their periodic IRQ
rate */
               if (errno == ENOTTY) {
                   fprintf(stderr,
                        "\n...Periodic IRQ rate is fixed\n");
                    goto done;
                }
                perror("RTC_IRQP_SET ioctl");
                exit(errno);
            }

            fprintf(stderr, "\n%ldHz:\t", tmp);
            fflush(stderr);

            /* Enable periodic interrupts */
            retval = ioctl(fd, RTC_PIE_ON, 0);
            if (retval == -1) {
                perror("RTC_PIE_ON ioctl");
                exit(errno);
            }

            for (i=1; i<21; i++) {
                /* This blocks */
                retval   =   read(fd,   &data,   sizeof(unsigned
long));
                if (retval == -1) {
                    perror("read");
                    exit(errno);
                }
                fprintf(stderr, " %d",i);
                fflush(stderr);
                irqcount++;
            }

            /* Disable periodic interrupts */
            retval = ioctl(fd, RTC_PIE_OFF, 0);
            if (retval == -1) {
                perror("RTC_PIE_OFF ioctl");
                exit(errno);
            }
        }

done:
        fprintf(stderr, "\n\n\t\t\t *** Test complete ***\n");

        close(fd);

        return 0;
}
```

More detail please reference "source/linux-2.6.35.3/Documentation/rtc.txt"

3.11.8 WatchDog

Usually an userspace daemon will notify the kernel watchdog driver via the/dev/watchdog special device file that userspace is still alive, at regular intervals. When such a notification occurs, the driver will usually tell the hardware watchdog that everything is in order, and that the watchdog should wait for yet another little while to reset the system. If userspace fails (RAM error, kernel bug, whatever), the notifications cease to occur, and the hardware watchdog will reset the system (causing a reboot) after the timeout occurs.

3.11.8.1 The Simplest API

All drivers support the basic mode of operation, where the watchdog activates as soon as /dev/watchdog is opened and will reboot unless the watchdog is pinged within a certain time, this time is called the timeout or margin. The simplest way to ping the watchdog is to write some data to the device. So a very simple watchdog daemon would look like this source file as below:

```
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>
#include <fcntl.h>

int main(void)
{
        int fd = open("/dev/watchdog", O_WRONLY);
        int ret = 0;
        if (fd == -1) {
             perror("watchdog");
             exit(EXIT_FAILURE);
        }
        while (1) {
             ret = write(fd, "\0", 1);
             if (ret != 1) {
                  ret = -1;
                  break;
             }
             sleep(10);
        }
        close(fd);
        return ret;
}
```

3.11.8.2 Magic Close feature

If a driver supports "Magic Close", the driver will not disable the watchdog unless a specific magic character 'V' has been sent to /dev/watchdog just before closing the file. If the userspace daemon closes the file without sending this special character, the driver will assume that the daemon (and userspace in general) died, and will stop pinging the watchdog without disabling it first. This will then cause a reboot if the watchdog is not re-opened in sufficient time.

3.11.8.3 The ioctl API

All conforming drivers also support an ioctl API.

Pinging the watchdog using an ioctl:

All drivers that have an ioctl interface support at least one ioctl, KEEPALIVE. This ioctl does exactly the same thing as a write to the watchdog device, so the main loop in the above program could be replaced with:

```
while (1) {
    ioctl(fd, WDIOC_KEEPALIVE, 0);
    sleep(10);
}
```

the argument to the ioctl is ignored.

Setting and getting the timeout:

For some drivers it is possible to modify the watchdog timeout on the fly with the SETTIMEOUT ioctl, those drivers have the WDIOF_SETTIMEOUT flag set in their option field. The argument is an integer representing the timeout in seconds. The driver returns the real

timeout used in the same variable, and this timeout might differ from the requested one due to limitation of the hardware.

```
int timeout = 45;
ioctl(fd, WDIOC_SETTIMEOUT, &timeout);
printf("The timeout was set to %d seconds\n", timeout);
```

This example might actually print "The timeout was set to 60 seconds" if the device has a granularity of minutes for its timeout.

Starting with the Linux 2.4.18 kernel, it is possible to query the current timeout using the GETTIMEOUT ioctl.

```
ioctl(fd, WDIOC_GETTIMEOUT, &timeout);
printf("The timeout was is %d seconds\n", timeout);
```

3.11.8.4 Pretimeouts:

Some watchdog timers can be set to have a trigger go off before the actual time they will reset the system. This can be done with an NMI, interrupt, or other mechanism. This allows Linux to record useful information (like panic information and kernel core-dumps) before it resets.

```
pretimeout = 10;
ioctl(fd, WDIOC_SETPRETIMEOUT, &pretimeout);
```

Note that the pretimeout is the number of seconds before the time when the timeout will go off. It is not the number of seconds until the pretimeout. So, for instance, if you set the timeout to 60 seconds and the pretimeout to 10 seconds, the pretimout will go of in 50 seconds. Setting a pretimeout to zero disables it.

There is also a get function for getting the pretimeout:

```
    ioctl(fd, WDIOC_GETPRETIMEOUT, &timeout);
    printf("The pretimeout was is %d seconds\n", timeout);
```

Not all watchdog drivers will support a pretimeout.

Get the number of seconds before reboot:

Some watchdog drivers have the ability to report the remaining time before the system will reboot. The WDIOC_GETTIMELEFT is the ioctl that returns the number of seconds before reboot.

```
    ioctl(fd, WDIOC_GETTIMELEFT, &timeleft);
    printf("The timeout was is %d seconds\n", timeleft);
```

3.11.8.5 Environmental monitoring:

All watchdog drivers are required return more information about the system, some do temperature, fan and power level monitoring, some can tell you the reason for the last reboot of the system. The GETSUPPORT ioctl is available to ask what the device can do:

```
        struct watchdog_info ident;
        ioctl(fd, WDIOC_GETSUPPORT, &ident);
```

the fields returned in the ident struct are:

identity	a string identifying the watchdog driver
firmware_version	the firmware version of the card if available
options	a flags describing what the device supports
WDIOF_OVERHEAT	Reset due to CPU overheat

The machine was last rebooted by the watchdog because the thermal limit was exceeded

WDIOF_FANFAULT	Fan failed

A system fan monitored by the watchdog card has failed

WDIOF_EXTERN1	External relay 1

External monitoring relay/source 1 was triggered. Controllers intended for real world applications include external monitoring pins that will trigger a reset.

WDIOF_EXTERN2	External relay 2

External monitoring relay/source 2 was triggered

WDIOF_POWERUNDER	Power bad/power fault

The machine is showing an undervoltage status

WDIOF_CARDRESET	Card previously reset the CPU

The last reboot was caused by the watchdog card

WDIOF_POWEROVER	Power over voltage

The machine is showing an overvoltage status. Note that if one level is under and one over both bits will be set - this may seem odd but makes sense.

WDIOF_KEEPALIVEPING	Keep alive ping reply

The watchdog saw a keepalive ping since it was last queried.

WDIOF_SETTIMEOUT	Can set/get the timeout

The watchdog can do pretimeouts.

WDIOF_PRETIMEOUT	Pretimeout (in seconds), get/set

For those drivers that return any bits set in the option field, the GETSTATUS and GETBOOTSTATUS ioctls can be used to ask for the current status, and the status at the last reboot, respectively.

```
int flags;
 ioctl(fd, WDIOC_GETSTATUS, &flags);

 or

 ioctl(fd, WDIOC_GETBOOTSTATUS, &flags);
```

Note that not all devices support these two calls, and some only support the GET-BOOTSTATUS call.

Some drivers can measure the temperature using the GETTEMP ioctl. The returned value is the temperature in degrees fahrenheit.

```
int temperature;
 ioctl(fd, WDIOC_GETTEMP, &temperature);
```

Finally the SETOPTIONS ioctl can be used to control some aspects of the cards operation.

```
int options = 0;
```

```
    ioctl(fd, WDIOC_SETOPTIONS, &options);
```

The following options are available:

```
        WDIOS_DISABLECARDTurn off the watchdog timer
        WDIOS_ENABLECARDTurn on the watchdog timer
        WDIOS_TEMPPANICKernel panic on temperature trip
```

More detail please reference "source/linux-2.6.35.3/Documentation/watchdog/watchdog-api.txt"

3.11.9 Audio

3.11.9.1 Kernel Configuration

To enable ALSA support you need at least to build the kernel with primary sound card support (CONFIG_SOUND). Since ALSA can emulate OSS, you don't have to choose any of the OSS modules.

Enable "OSS API emulation" (CONFIG_SND_OSSEMUL) and both OSS mixer and PCM supports if you want to run OSS applications with ALSA.

If you want to support the WaveTable functionality on cards such as SB Live! then you need to enable "Sequencer support" (CONFIG_SND_SEQUENCER).

To make ALSA debug messages more verbose, enable the "Verbose printk" and "Debug" options. To check for memory leaks, turn on "Debug memory" too. "Debug detection" will add checks for the detection of cards.

Please note that all the ALSA ISA drivers support the Linux isapnp API (if the card supports ISA PnP). You don't need to configure the cards using isapnptools.

3.11.9.2 Creating ALSA Devices

This depends on your distribution, but normally you use the /dev/MAKEDEV script to create the necessary device nodes. On some systems you use a script named 'snd-devices'.

3.11.9.3 Module Parameters

The user can load modules with options. If the module supports more than one card and you have more than one card of the same type then you can specify multiple values for the option separated by commas.

More detail please reference "source/linux-2.6.35.3/Documentation/sound/alsa/ALSA-Configuration.txt"

3.11.10 Keypad/Touchscreen

3.11.10.1 Introduction

This is a collection of drivers that is designed to support all input devices under Linux. While it is currently used only on for USB input devices, future use (say 2.5/2.6) is expected to expand to replace most of the existing input system, which is why it lives in drivers/input/ instead of drivers/usb/.

The centre of the input drivers is the input module, which must be loaded before any other of the input modules - it serves as a way of communication between two groups of modules:

A. Device drivers

These modules talk to the hardware (for example via USB), and provide events (keystrokes, mouse movements) to the input module.

B. Event handlers

These modules get events from input and pass them where needed via various interfaces - keystrokes to the kernel, mouse movements via a simulated PS/2 interface to GPM and X and so on.

3.11.10.2 Simple Usage

For the most usual configuration, with one USB mouse and one USB keyboard, you'll have to load the following modules (or have them built in to the kernel):

```
input
mousedev
keybdev
usbcore
uhci_hcd or ohci_hcd or ehci_hcd
usbhid
```

After this, the USB keyboard will work straight away, and the USB mouse will be available as a character device on major 13, minor 63:

```
      crw-r--r--   1 root      root       13,  63 Mar 28 22:45
mice
```

This device has to be created.

The commands to create it by hand are:

```
cd /dev
mkdir input
mknod input/mice c 13 63
```

After that you have to point GPM (the textmode mouse cut&paste tool) and XFree to this device to use it - GPM should be called like:

```
gpm -t ps2 -m /dev/input/mice
```

And in X:

```
Section "Pointer"
    Protocol    "ImPS/2"
    Device      "/dev/input/mice"
    ZAxisMapping 4 5
EndSection
```

When you do all of the above, you can use your USB mouse and keyboard.

3.11.10.3 Detailed Description

1. **Device drivers**

Device drivers are the modules that generate events. The events are however not useful without being handled, so you also will need to use some of the modules from section 3.10.9.3.2.

A. usbhid

usbhid is the largest and most complex driver of the whole suite. It handles all HID devices, and because there is a very wide variety of them, and because the USB HID specification isn't simple, it needs to be this big.

Currently, it handles USB mice, joysticks, gamepads, steering wheels keyboards, trackballs and digitizers.

However, USB uses HID also for monitor controls, speaker controls, UPSs, LCDs and many other purposes.

The monitor and speaker controls should be easy to add to the hid/input interface, but for the UPSs and LCDs it doesn't make much sense. For this, the hiddev interface was designed. See Documentation/usb/hiddev.txt for more information about it.

The usage of the usbhid module is very simple, it takes no parameters, detects everything automatically and when a HID device is inserted, it detects it appropriately.

However, because the devices vary wildly, you might happen to have a device that doesn't work well. In that case #define DEBUG at the beginning of hid-core.c and send me the syslog traces.

B. usbmouse

For embedded systems, for mice with broken HID descriptors and just any other use when the big usbhid wouldn't be a good choice, there is the usbmouse driver. It handles USB mice only. It uses a simpler HIDBP protocol. This also means the mice must support this simpler protocol. Not all do. If you don't have any strong reason to use this module, use usbhid instead.

C. usbkbd

Much like usbmouse, this module talks to keyboards with a simplified HIDBP protocol. It's smaller, but doesn't support any extra special keys. Use usbhid instead if there isn't any special reason to use this.

D. wacom

This is a driver for Wacom Graphire and Intuos tablets. Not for Wacom PenPartner, that one is handled by the HID driver. Although the Intuos and Graphire tablets claim that they are HID tablets as well, they are not and thus need this specific driver.

E. iforce

A driver for I-Force joysticks and wheels, both over USB and RS232. It includes ForceFeedback support now, even though Immersion Corp. considers the protocol a trade secret and won't disclose a word about it.

2. Event handlers

Event handlers distribute the events from the devices to userland and kernel, as needed.

A. keybdev

keybdev is currently a rather ugly hack that translates the input events into architecture-specific keyboard raw mode (Xlated AT Set2 on x86), and passes them into the handle_scancode function of the keyboard.c module. This works well enough on all architectures that keybdev can generate rawmode on, other architectures can be added to it.

The right way would be to pass the events to keyboard.c directly, best if keyboard.c would itself be an event handler. This is done in the input patch, available on the webpage mentioned below.

B. mousedev

mousedev is also a hack to make programs that use mouse input work. It takes events from either mice or digitizers/tablets and makes a PS/2-style (a la /dev/psaux) mouse device available to the userland. Ideally, the programs could use a more reasonable interface, for example evdev

Mousedev devices in /dev/input (as shown above) are:

```
      crw-r--r--   1 root     root      13,  32 Mar 28 22:45
mouse0
      crw-r--r--   1 root     root      13,  33 Mar 29 00:41
mouse1
      crw-r--r--   1 root     root      13,  34 Mar 29 00:41
mouse2
      crw-r--r--   1 root     root      13,  35 Apr  1 10:50
mouse3
      ...
      ...
      crw-r--r--   1 root     root      13,  62 Apr  1 10:50
mouse30
      crw-r--r--   1 root     root      13,  63 Apr  1 10:50
mice
```

Each 'mouse' device is assigned to a single mouse or digitizer, except the last one - 'mice'. This single character device is shared by all mice and digitizers, and even if none are connected, the device is present. This is useful for hotplugging USB mice, so that programs can open the device even when no mice are present.

CONFIG_INPUT_MOUSEDEV_SCREEN_[XY] in the kernel configuration are the size of your screen (in pixels) in XFree86. This is needed if you want to use your digitizer in X, because its movement is sent to X via a virtual PS/2 mouse and thus needs to be scaled accordingly. These values won't be used if you use a mouse only.

Mousedev will generate either PS/2, ImPS/2 (Microsoft IntelliMouse) or ExplorerPS/2 (IntelliMouse Explorer) protocols, depending on what the program reading the data wishes. You can set GPM and X to any of these. You'll need ImPS/2 if you want to make use of a wheel on a USB mouse and ExplorerPS/2 if you want to use extra (up to 5) buttons.

C. joydev

Joydev implements v0.x and v1.x Linux joystick api, much like drivers/char/joystick/joystick.c used to in earlier versions. See joystick-api.txt in the Documentation subdirectory for details. As soon as any joystick is connected, it can be accessed in /dev/input on:

```
      crw-r--r--   1 root     root      13,   0 Apr  1 10:50 js0
      crw-r--r--   1 root     root      13,   1 Apr  1 10:50 js1
      crw-r--r--   1 root     root      13,   2 Apr  1 10:50 js2
      crw-r--r--   1 root     root      13,   3 Apr  1 10:50 js3
      ...
```

And so on up to js31.

D. evdev

evdev is the generic input event interface. It passes the events generated in the kernel straight to the program, with timestamps. The API is still evolving, but should be useable now.

This should be the way for GPM and X to get keyboard and mouse events. It allows for multihead in X without any specific multihead kernel support. The event codes are the same on all architectures and are hardware independent.

The devices are in /dev/input:

```
       crw-r--r--   1 root      root       13,  64 Apr  1 10:49
event0
       crw-r--r--   1 root      root       13,  65 Apr  1 10:50
event1
       crw-r--r--   1 root      root       13,  66 Apr  1 10:50
event2
       crw-r--r--   1 root      root       13,  67 Apr  1 10:50
event3
       ...
```

And so on up to event31.

3. Verifying if it works

Typing a couple keys on the keyboard should be enough to check that a USB keyboard works and is correctly connected to the kernel keyboard driver.

Doing a cat /dev/input/mouse0 (c, 13, 32) will verify that a mouse is also emulated, characters should appear if you move it.

You can test the joystick emulation with the 'jstest' utility, available in the joystick package (see Documentation/input/joystick.txt).

You can test the event devices with the 'evtest' utility available in the LinuxConsole project CVS archive (see the URL below).

4. Event interface

Should you want to add event device support into any application (X, gpm, svgalib ...) I <vojtech@ucw.cz> will be happy to provide you any help I can. Here goes a description of the current state of things, which is going to be extended, but not changed incompatibly as time goes:

You can use blocking and nonblocking reads, also select() on the /dev/input/eventX devices, and you'll always get a whole number of input events on a read. Their layout is:

```
struct input_event {
       struct timeval time;
       unsigned short type;
       unsigned short code;
       unsigned int value;
};
```

'time' is the timestamp, it returns the time at which the event happened.

Type is for example EV_REL for relative moment, EV_KEY for a keypress or release. More types are defined in include/linux/input.h.

'code' is event code, for example REL_X or KEY_BACKSPACE, again a complete list is in include/linux/input.h.

'value' is the value the event carries. Either a relative change for EV_REL, absolute new value for EV_ABS (joysticks ...), or 0 for EV_KEY for release, 1 for keypress and 2 for autorepeat.

More detail please reference "source/linux-2.6.35.4/Documentation/input/input.txt".

3.12 Backlight Adjustment

The brightness of the display backlight can be adjusted in a range from 0 to 255. The value is exported as a virtual file in the sysfs under /sys/class/backlight/pwm_backlight/brightness. It can be accessed using the standard file operations open(), read(), write() and close().

Example 1: Reading and adjusting the current backlight brightness on the console

```
root #cat /sys/class/backlight/pwm-backlight/brightness
255
root # echo 100 > /sys/class/backlight/pwm-backlight/bright-
ness
root #cat /sys/class/backlight/pwm-backlight/brightness
100
```

Please note that this value is not persistent, i.e. it gets lost when the device is rebooted. In order to change the brightness permanently, it has to be set in the XML configuration, which is also mapped into the sysfs under /sys/class/misc/guf_xml/configurationFile/variables/display/backlight/level_ac.

The PWM settings used allow the adjustment of the duty cycle in 255 steps.