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SAM4S-EK2

User Guide

11176A–ATARM–24-Sep-12

Section 1

Section 2

Section 3

Section 4

Section 1
Introduction

1.1 SAM4S Evaluation Kit

The SAM4S Evaluation Kit (SAM4S-EK2) enables evaluation capabilities and code development of applications running on a SAM4SD32 device.

1.2 User Guide

This guide focuses on the SAM4S-EK2 board as an evaluation platform. It is made up of 6 sections:

- Section 1 includes references, applicable documents, acronyms and abbreviations.
- Section 2 describes the kit contents, its main features and specifications.
- Section 3 provides instructions to power up the SAM4S-EK2 and describes how to use it.
- Section 4 provides board specifications, describes the development environment and presents the hardware resources, default jumper, switch settings and connectors.
- Section 5 provides schematics.
- Section 6 provides troubleshooting instructions.

1.3 References and Applicable Documents

Table 1-1. References and Applicable Documents

Title	Comment
SAM4SD32 Datasheet	www.atmel.com

Section 2

Kit Contents

2.1 Deliverables

The Atmel® SAM4S-EK2 toolkit contains the following items:

- Board:
  - a SAM4S-EK2 board
  - a universal input AC/DC power supply with US, Europe and UK plug adapters
- Cables:
  - one USB cable
  - one serial RS232 cable
- A Welcome Letter

Figure 2-1. Unpacked SAM4S-EK2

Unpack and inspect the kit carefully. Contact your local Atmel distributor, should you have issues concerning the contents of the kit.

2.2 Electrostatic Warning

The SAM4S-EK2 board is shipped in a protective anti-static bag. The board must not be subjected to high electrostatic potentials. A grounding strap or similar protective device should be worn when handling the board. Avoid touching the components or any other metallic element of the board.

Section 3

Power Up

3.1 Power up the Board

Unpack the board taking care to avoid electrostatic discharge. Unpack the power supply, select the right power plug adapter corresponding to that of your country, and insert it into the power supply.

Connect the power supply DC connector to the board and plug the power supply to an AC power plug.

The board LCD should light up and display a welcome page. Then, click or touch the icons displayed on the screen and enjoy the demo.

3.2 Sample Code and Technical Support

After boot up, you can run some sample code or your own application on the development kit. You can download sample code and get technical support from the Atmel web site: http://www.atmel.com

Section 4

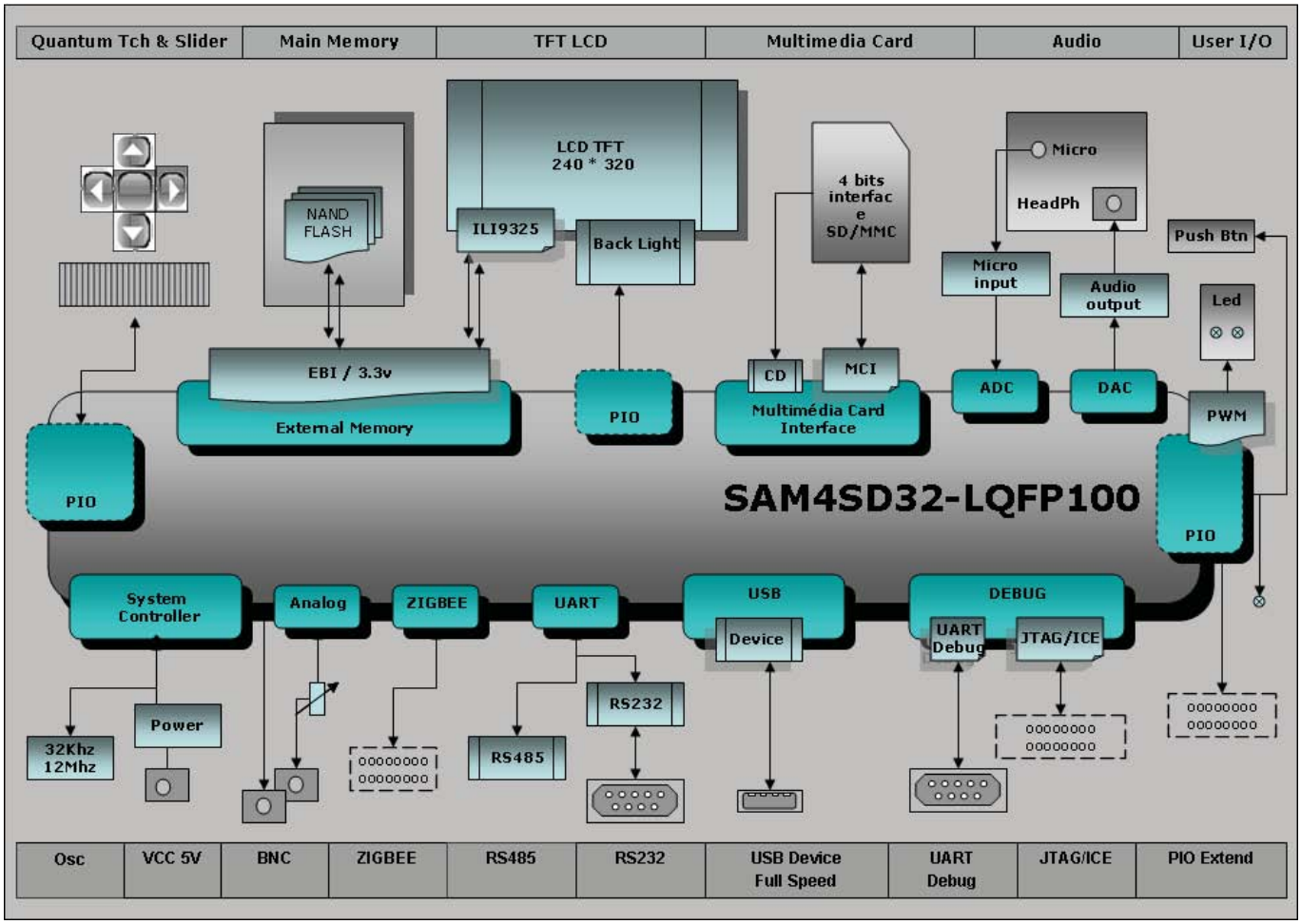
Evaluation Kit Hardware

4.1 Board Overview

This section introduces the Atmel SAM4S-EK2 Evaluation Kit design. It introduces system-level concepts, such as power distribution, memory, and interface assignments.

The SAM4S-EK2 board is based on the integration of an ARM® Cortex®-M4 processor with on-board NAND Flash and a set of popular peripherals. It is designed to provide a high performance processor evaluation solution with high flexibility for various kinds of applications.

Figure 4-1. SAM4S-EK2 Block Diagram



4.2 Features List

Here is the list of the main board components and interfaces:

- SAM4SD32 chip LQFP100 package with optional socket footprint
- 12 MHz crystal
- 32.768 KHz crystal
- Optional SMB connector for external system clock input
- NAND Flash
- 2.8 inch TFT color LCD display with touch panel and backlight
- UART port with level shifter circuit
- USART port with level shifter circuit multiplexed with RS485 port with level shifter circuit
- Microphone input and mono/stereo headphone jack output
- SD/MMC interface
- Reset button: NRST
- User buttons: Left and Right
- QTouch® buttons: Up, Down, Left, Right, Valid and Slider
- Full Speed USB device port
- JTAG/ICE port
- On-board power regulation
- Two user LEDs
- Power LED
- BNC connector for ADC input
- BNC connector for DAC output
- User potentiometer connected to the ADC input
- ZigBEE connector
- 2x32 bit PIO connection interfaces (PIOA, PIOC) and 1x16 bit PIO connection interface (PIOB)

4.3 Function Blocks

4.3.1 Processor

The SAM4S-EK2 is equipped with a SAM4SD32 device in LQFP100 package.

4.3.2 Memory

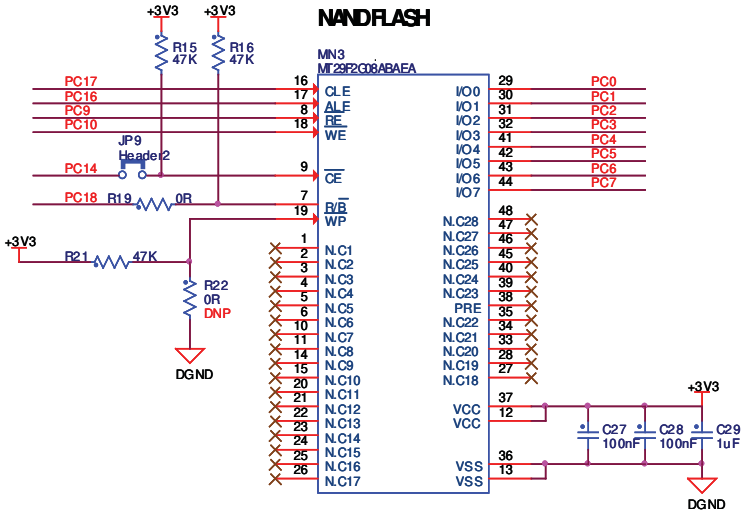
The SAM4SD32 chip embeds:

- 2048 Kbytes of embedded Flash
- 160 Kbytes of embedded SRAM
- 16 Kbytes of ROM with embedded BootLoader routines (UART, USB) and In-Application Programming functions (IAP) routines

The SAM4SD32 features an External Bus Interface (EBI) that permits interfacing to a broad range of external memories and virtually to any parallel peripheral. The SAM4S-EK2 board is equipped with a memory device connected to the SAM4 EBI:

- One NAND Flash MT29F2G08ABAEA.

Figure 4-2. NAND Flash



NCS0 chip select signal is used for NAND Flash chip selection. Furthermore, a dedicated jumper can disconnect it from the on-board memories, thereby letting NCS0 free for other custom purposes.

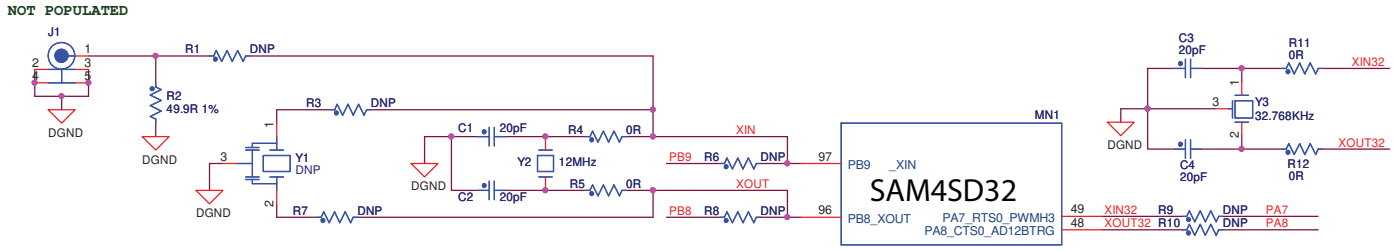
4.3.3 Clock Circuitry

The clock generator of a SAM4SD32 microcontroller is composed of:

- A Low Power 32.768 Hz Slow Clock Oscillator with bypass mode
- A 3 to 20 MHz Crystal Oscillator, which can be bypassed (12 MHz needed in case of USB)
- A factory programmed fast internal RC Oscillator. 3 output frequencies can be selected: 4 (default value), 8 or 12 MHz.
- A 60 to 130 MHz PLL (PLLB) providing a clock for the USB Full Speed Controller
- A 60 to 130 MHz programmable PLL (PLLA), capable to provide the clock MCK to the processor and to the peripherals. The input frequency of PLLA is from 7.5 to 20 MHz

The SAM4S-EK2 board is equipped with one 12 MHz crystal, optional Piezoelectric Ceramic Resonator 12 MHz (Murata ref. CSTCE12M0G15L99-R0), one 32.768 Hz crystal and an external clock input connector (optional, not populated by default).

Figure 4-3. External Clock Source



The SAM4SD32 chip internally generates the following clocks:

- SLCK, the Slow Clock, which is the only permanent clock of the system
- MAINCK, the output of the Main Clock Oscillator selection: either a Crystal Oscillator or a 4/8/12 MHz Fast RC Oscillator
- PLLACK, the output of the Divider and 60 to 130 MHz programmable PLL (PLLA)
- PLLBCK, the output of the Divider and 60 to 130 MHz programmable PLL (PLLB)

4.3.4 Reset Circuitry

On-board NRST button BP1 provides an external reset control of the SAM4SD32.

The NRST pin is bidirectional. It is handled by the on-chip reset controller. It can be driven low to provide a reset signal out to the external components. Conversely, it can be asserted low from the outside to reset the microcontroller Core and the peripherals. The NRST pin integrates a permanent pull-up resistor of 100 kOhm to VDDIO.

On the SAM4S-EK2 board, the NRST signal is connected to the LCD module and JTAG port.

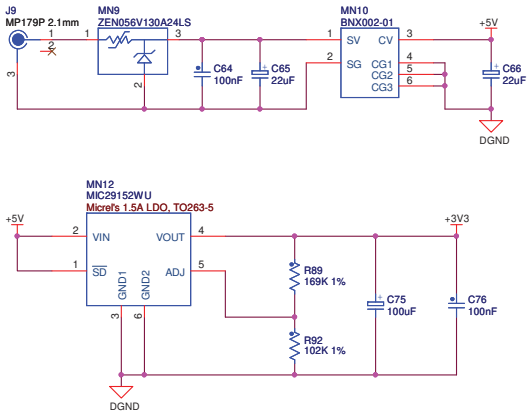
Note: At power-on, the NRST signal is asserted with a default duration of 2 clock cycles. That duration may not be sufficient to correctly reset any other system or board devices connected to that signal. First, in your custom application, you need to check for these device's datasheets about reset duration requirements. Then, you need to set an appropriate configuration in the NRST Manager. This is done through the ERSTL field in the RSTC_MR register. The NRST duration is thereby configurable between 60 µs and 2 s, whether it is subsequently activated by a software reset or a user reset. Refer to the SAM4SD32 datasheet for in-depth information.

4.3.5 Power Supply and Management

The SAM4S-EK2 board is supplied with an external 5V DC block through input J9. It is protected by a PolyZen diode (MN9) and an LC combinatory filter (MN10). The PolyZen is used in the event of an incorrect power supply connection.

The adjustable LDO regulator MN12 is used for the 3.3V rail main supply. It powers all the 3.3V components on the board.

Figure 4-4. Power Block



The SAM4SD32 product has different types of power supply pins:

- VDDIN pin:
  Power for the internal voltage regulator, ADC, DAC, and analog comparator power supplies.
  The voltage ranges from 1.8V to 3.6V.

- VDDIO pins:
  Power for the Peripherals I/O lines.
  The voltage ranges from 1.62V to 3.6V.
- VDDOUT pin:
  Output of the internal voltage regulator.
- VDDCORE pins:
  Power for the core, including the processor, embedded memories and peripherals.
  The voltage ranges from 1.62V to 1.95V.
- VDDPLL pin:
  Power for the PLL A, PLL B and 12 MHz oscillator.
  The voltage ranges from 1.62V to 1.95V.

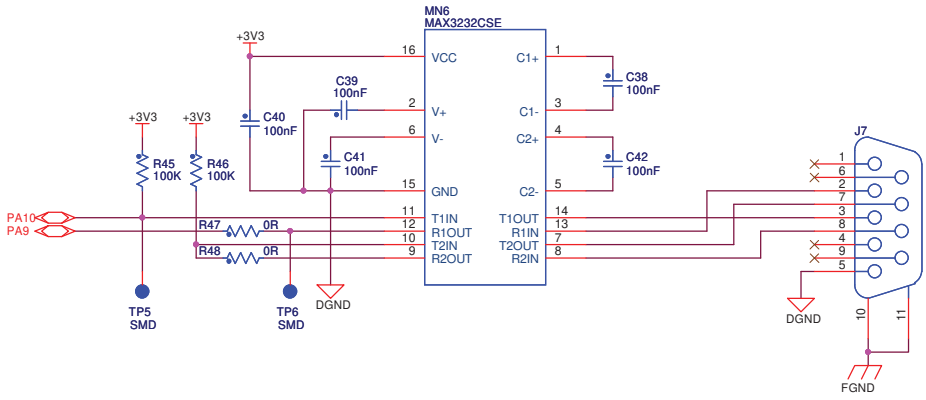
  Note: VDDPLL should be decoupled and filtered from VDDCORE.

4.3.6 UART

The Universal Asynchronous Receiver Transmitter features a two-pin UART that can be used for communication and trace purposes. It offers an ideal channel for in-situ programming solutions. This UART is associated with two PDC channels to reduce the processor time on packet handling.

This two-pin UART (TXD and RXD only) is buffered through an RS232 Transceiver MN6 and brought to the DB9 male connector J7.

Figure 4-5. UART



4.3.7 USART

The Universal Synchronous/Asynchronous Receiver Transmitter (USART) provides one full duplex universal synchronous/asynchronous serial link. The data frame format is extensively configurable (data length, parity, number of stop bits) to support a broad range of serial communication standards. The USART is also associated with PDC channels for TX/RX data access.

Note: For design optimization purposes, both transmitters have been implemented on the same PIO lines, that is PA21, 22, 23, 24, 25.

To avoid any electrical conflict, the RS485 transceiver is isolated from the receiving line PA21.

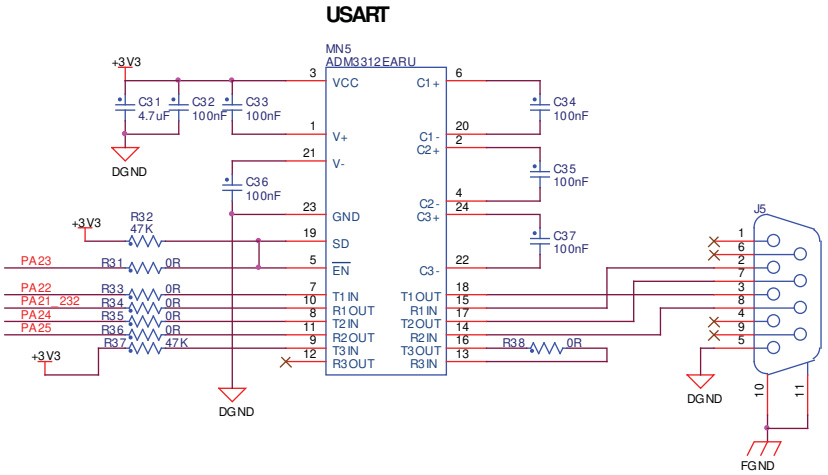
Should you need to implement an RS485 channel in place of the RS232, follow the procedure below:

1. make sure your software will permanently set PA23 to a high level - this will permanently disable the RS232 receiver.
2. change JP31 to make sure that 2-3 pins are connected.

4.3.7.1 RS232

SAM4S-EK2 connects the USART1 bus (including TXD, RXD, RTS, CTS handshake signal controls and EN command) to the DB9 male connector J5 through the RS232 Transceiver MN5.

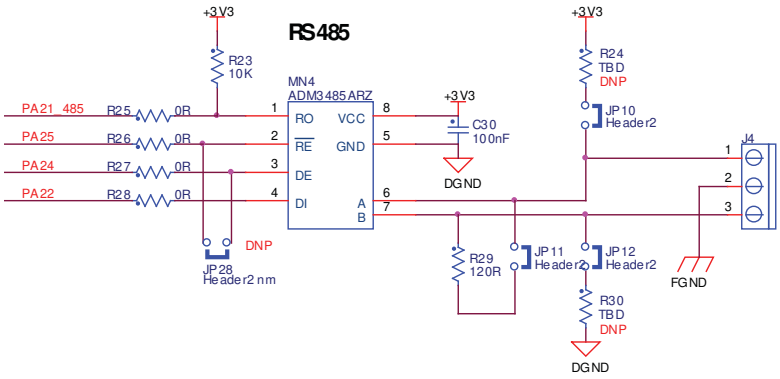
Figure 4-6. USART Evaluation Kit Hardware



4.3.7.2 RS485

As noticed above, the USART1 is shared with the RS485 port, connected to the transceiver MN4, connected to the 3-point connector J4. The design includes selectable jumpers for RS485 bus termination resistors selection (JP10, JP11, JP12).

Figure 4-7. RS485



4.3.8 Display Interface

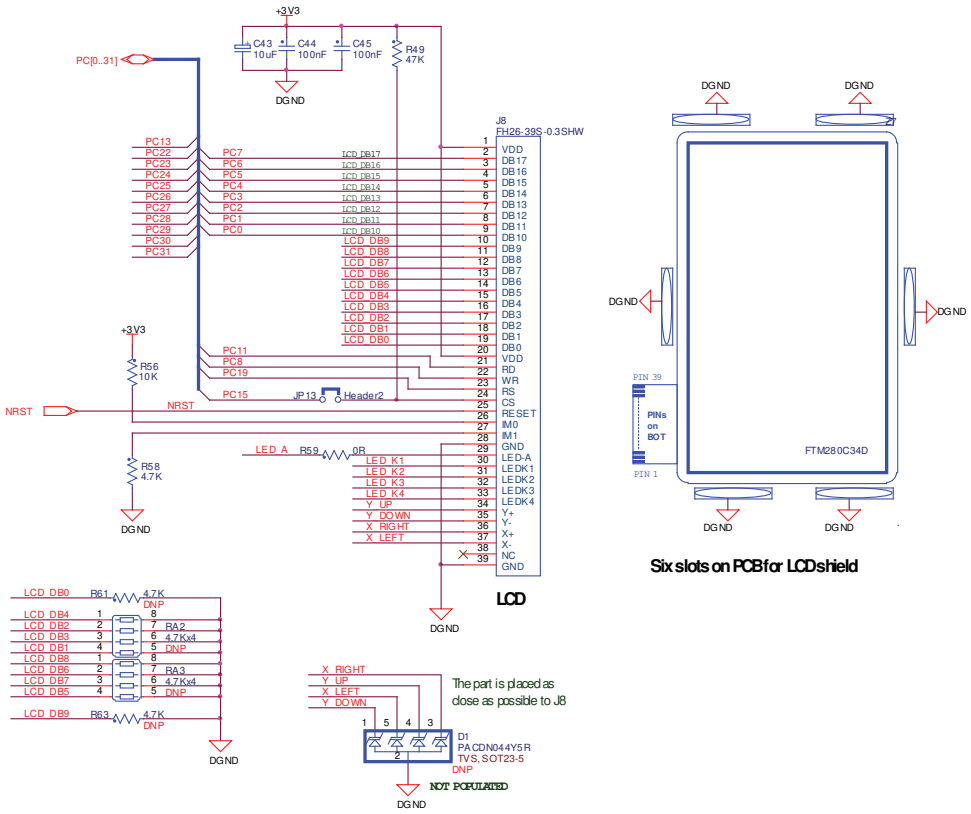
The SAM4S-EK2 carries a TFT Transmissive LCD module with touch panel, FTM280C34D. Its integrated driver IC is ILI9325. The LCD display area is 2.8 inches diagonally measured, with a native resolution of 240 x 320 dots.

4.3.8.1 LCD Module

The LCD module gets reset from the NRST signal. As explained, this NRST is shared with the JTAG port and the push-button BP1. The LCD chip select signal is connected to NCS1; the jumper JP13 can disconnect it so that this PIO line is available for other custom usage.

The SAM4SD32 communicates with the LCD through PIOC where an 8-bit parallel “8080-like” protocol data bus has to be implemented in software.

Figure 4-8. LCD Block

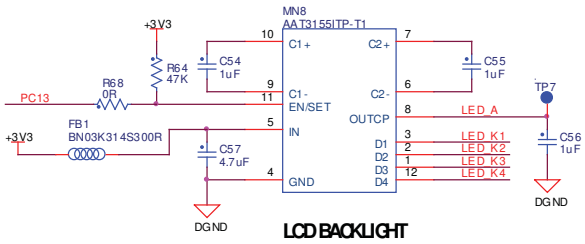


4.3.8.2 Backlight Control

The LCD backlight is made of four integrated white chip-LEDs arranged in parallel. These are driven by an AAT3155 charge pump, MN8. The AAT3155 is controlled by the SAM4SD32 through a single PIO line PC13 interface; the 0 Ohm resistor R68 is mounted in series on this line, which permits to use it for other custom purposes. In that case, the pull-up resistor R64 maintains the charge pump permanently enabled by default.

On the anode drive line, a 0 Ohm resistor R59 is implemented in series for an optional current limitation.

Figure 4-9. Backlight Control



4.3.8.3 Touch Screen Interface

The LCD module integrates a 4-wire touch panel controlled by MN7 (ADS7843) which is a slave device on the SAM4SD32 SPI bus. The controller sends back the information about the X and Y positions, as well as a measurement for the pressure applied to the touch panel. The touch panel can be used with either a stylus or a finger.

The ADS7843 touch panel controller connects to the SPI0 interface via the NPCS0 control signal. Two interrupt signals are connected and provide events information back to the microcontroller: PenIrq and Busy.

Note: PenIrq (PA16) is shared with ZigBEE signal IRQ0.
Busy (PA17) is shared with ZigBEE signal IRQ1.
Therefore, if using a ZigBEE interface in concurrence with the TouchScreen controller, take care not to have both drivers enabled at the same time on either PA16 or PA17.

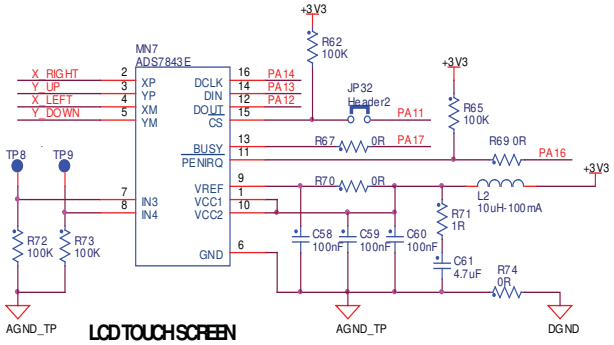
For that purpose, 0 Ohm resistors have been implemented on these PIO lines in order to disconnect either end driver from the other:

- On the touch panel controller side, R67 and R69.
- On ZigBEE side, R117 and R120.

For further information, refer to the "Schematics" section.

Touch ADC auxiliary inputs IN3/IN4 of the ADS7843 are connected to test points (TP8, TP9) for optional function extension.

Figure 4-10. Touch Panel Control



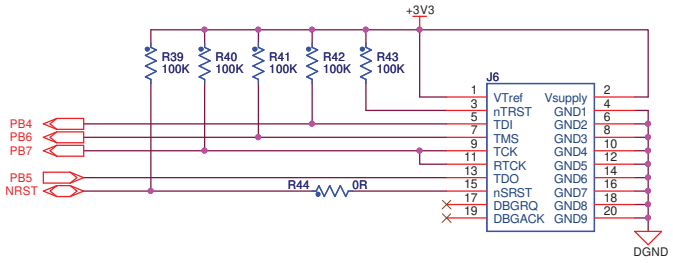
4.3.9 JTAG/ICE

A standard 20-pin JTAG/ICE connector is implemented on the SAM4S-EK2 for the connection of a compatible ARM JTAG emulator interface, such as the SAM-ICE from Segger.

Notes: ***1.*** The NRST signal is connected to BP1 system button and is also used to reset the LCD module. The 0 ohm resistor R44 may be removed in order to isolate the JTAG port from this system reset signal.

2. The TDO pin is in input mode with the pull-up resistor disabled when the Cortex M4 is not in debug mode. To avoid current consumption on VDDIO and/or VDDCORE due to floating input, the internal pull-up resistor corresponding to this PIO line must be enabled.

Figure 4-11. JTAG Interface



4.3.10 Audio Interface

The SAM4S-EK2 board supports both audio recording and playback.

The audio volume can be adjusted using the potentiometer RV1, and the microphone amplifier gain can be adjusted via jumpers (fixed gain of 24 or 26 dB).

4.3.10.1 Microphone Input

The embedded microphone is connected to an audio pre-amplifier using the TS922 operational amplifier (MN11). The gain is set by using JP14 and JP15 jumpers; both must be set or removed at the same time.

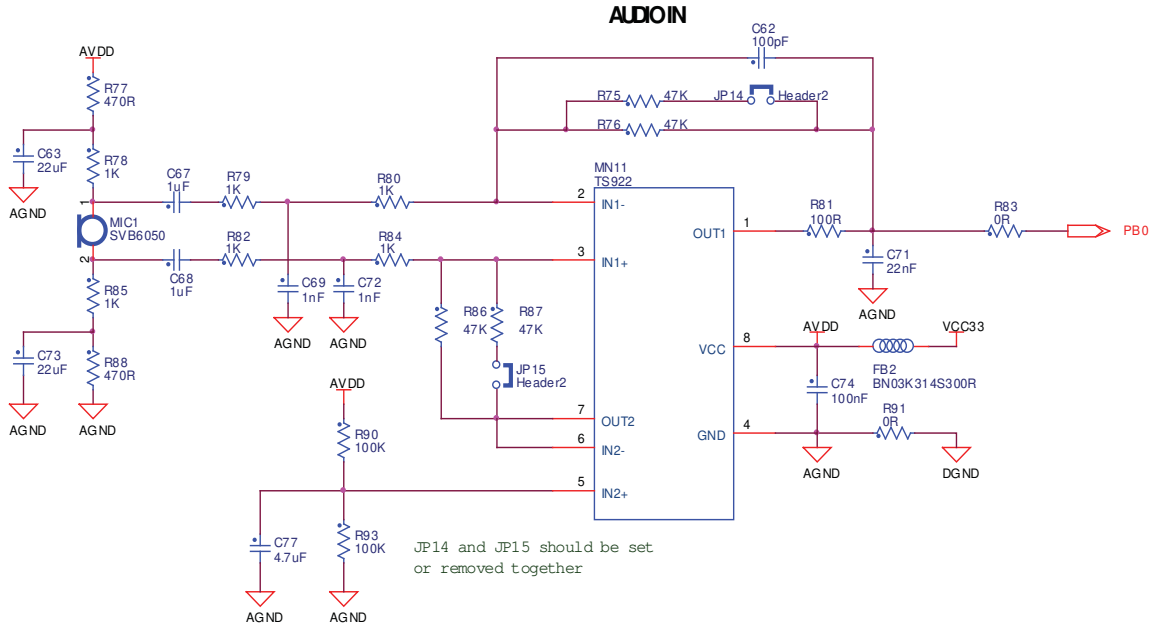
By modifying the jumper positions, you can select each of the following gain values:

- 20 dB (default setting, both JP14 and JP15 are off)
- 26 dB (both JP14 and JP15 are on).

Notes: ***1.*** R83 is a default 0 Ohm resistor that enables the disconnection of PB0 from the audio input path for custom usage.

2. The audio pre-amplifier MN11 is powered by a dedicated low dropout regulator MIC5219-3.3 (MN14).

Figure 4-12. Microphone Input

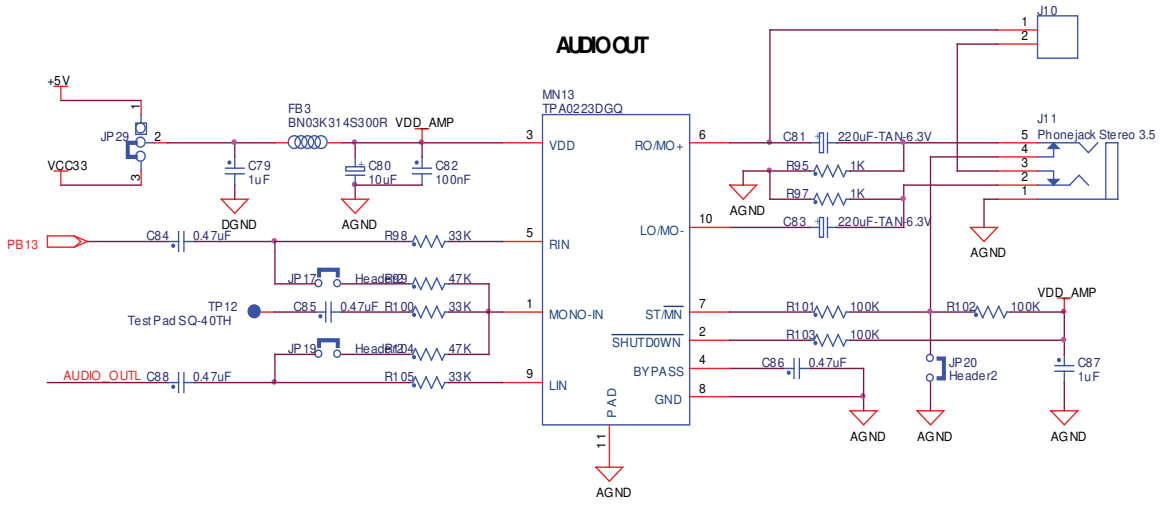


4.3.10.2 Headphone Output

The SAM4S-EK2 evaluation kit supports mono/stereo audio playback driven by a TPA0223 audio amplifier connected to two DAC channels of the microcontroller.

The TPA0223 is a 2W mono Bridge-Tied-Load (BTL) amplifier designed to drive speakers with as low as 4 Ohm impedance. The amplifier can be reconfigured on the fly to drive two stereo Single-Ended (SE) signals into head phones.

Figure 4-13. Headphone Output



Using a readily available 1/8-in. (3,5 mm) stereo headphone jack, the control switch is closed when no plug is inserted. When closed, a 100-kOhm/1-kOhm divider pulls the ST/MN input low. When a jack plug is inserted, the 1-kOhm resistor is disconnected and the ST/MN input is pulled high. The mono speaker (J10 connector) is also physically disconnected from the RO/MO+ output so that no sound is heard from the speaker while the headphones are inserted.

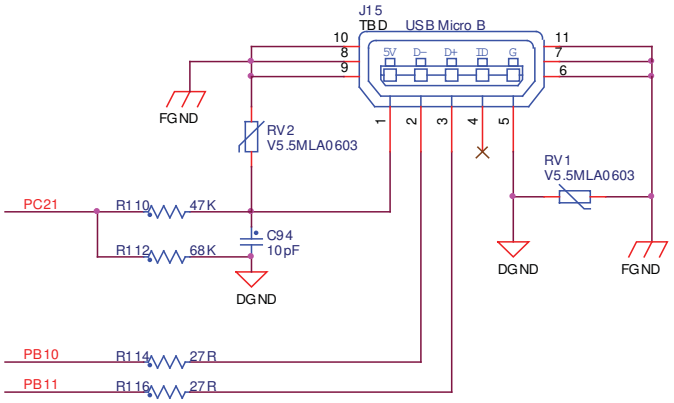
4.3.11 USB Device

The SAM4SD32 UDP port is compliant with the Universal Serial Bus (USB) rev 2.0 Full Speed device specification. J15 is a micro B-type receptacle for USB device.

Both 27-Ohm resistors R114 and R116 build up a 90-Ohm differential impedance together with the (embedded) 6-Ohm output impedance of the SAM4SD32 full speed channel drivers.

R110 and R112 build up a divider bridge from VBUS +5V to implement plug-in detection (5V level gets lowered to a PIO compatible 3.3V level) through PC21.

Figure 4-14. USB



USB

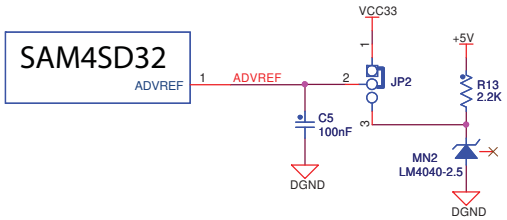
4.3.12 Analog Interface

4.3.12.1 Analog Reference

The 2.5V voltage reference is based on a LM4040 (Precision Micropower Shunt Voltage Reference).

This ADVREF level can be set as 2.5V or 3.3V via the jumper JP2.

Figure 4-15. Analog Vref



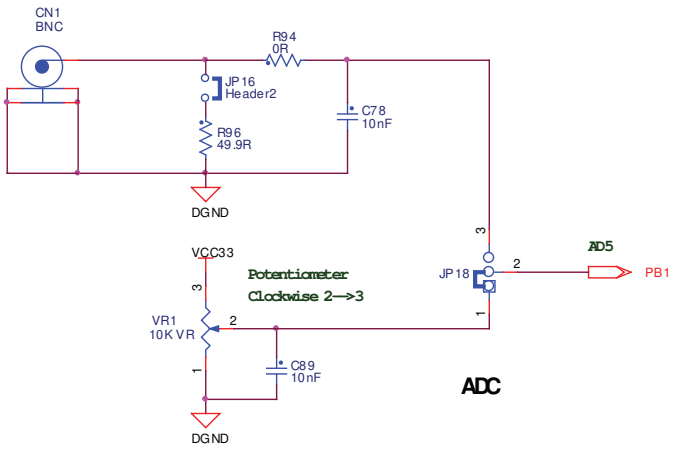
4.3.12.2 Analog Input

The BNC connector CN1 is connected to the ADC port PB1 as an external analog input. An on-board 50-Ohm resistor termination can be applied by closing jumper JP16. A low pass filter can be implemented for the BNC connector CN1 by replacing R94 and C78 with custom resistor and capacitor values, depending on your application requirements.

A 10-KOhm potentiometer (VR1) is also connected to this channel to implement an easy access to ADC programming and debugging (or implement an analog user control like display brightness, volume, etc.).

Either of these two functions can be selected by jumper JP18.

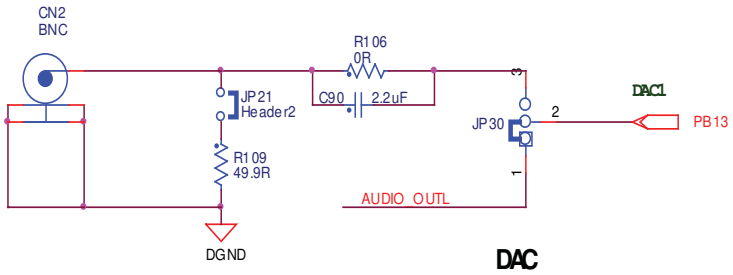
Figure 4-16. ADC Input



4.3.12.3 Analog Output

The BNC connector CN2 is connected to the DAC port PB13 and provides an external analog output. An on-board 50-Ohm resistor termination can be enabled by closing jumper JP21. A filter can be implemented on this output channel by replacing R106 and C90 with appropriate resistor and capacitor values, depending on the application requirements.

Figure 4-17. DAC Output



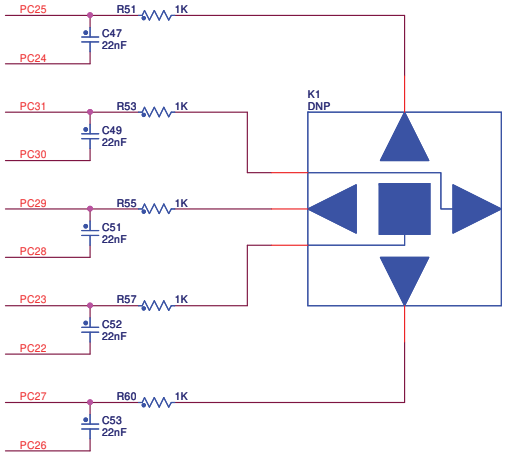
4.3.13 QTouch Elements

QTouch keys consist in a series of sensors formed by the association of a copper area and the capacitive effect of human fingers approaching it.

4.3.13.1 Keys

The SAM4S-EK2 implements five individual capacitive touch keys (UP, DOWN, RIGHT, LEFT and VALID) using five pairs of PIO.

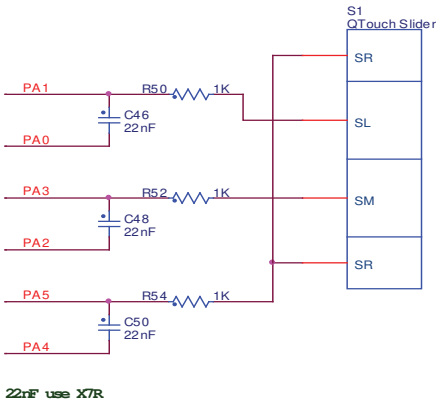
Figure 4-18. QST Keys



4.3.13.2 Slider

A group of channels forms a Slider. A Slider is composed of three channels for a QTouch acquisition method using three pairs of PIOs. Such a sensor is used to detect a linear finger displacement on a sensitive area. A typical implementation is volume control.

Figure 4-19. QT_Slider

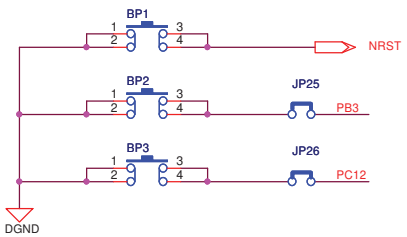


4.3.14 User Buttons

There are two mechanical user buttons on the SAM4S-EK2, which are connected to PIO lines and defined to be "left" and "right" buttons by default.

In addition, a mechanical button controls the system reset, signal NRST.

Figure 4-20. System Buttons

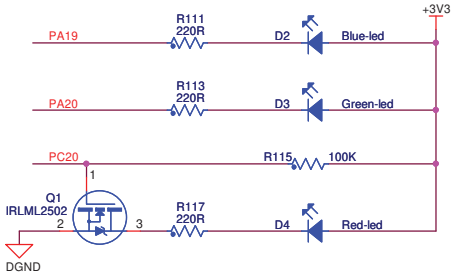


4.3.15 LEDs

There are three LEDs on the SAM4S-EK2 board:

- A blue LED (D2) and a green LED (D3), which are user defined and controlled by the GPIO.
- A red LED (D4), which is a power LED indicating that the 3.3V power rail is active. It is also controlled by the GPIO and can be treated as a user LED as well. The only difference with the two others is that it is controlled through a MOS transistor. By default, the PIO line is disabled; a pull-up resistor controls the MOS to light the LED when the power is ON.

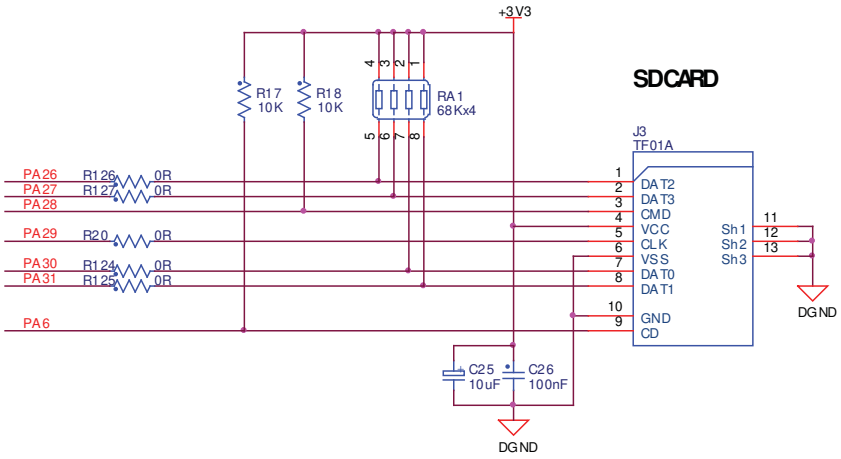
Figure 4-21. LEDs



4.3.16 SD/MMC Card

The SAM4S-EK2 has a high-speed 4-bit multimedia MMC interface, which is connected to a 4-bit SD/MMC micro card slot featuring a card detection switch.

Figure 4-22. SD Card

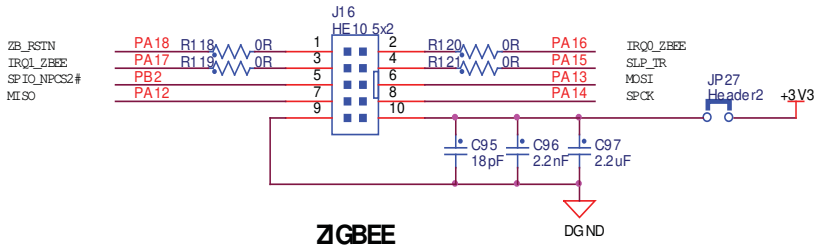


4.3.17 ZigBEE

SAM4S-EK2 has a 10-pin male connector for the RZ600 ZigBEE module.

Note: 0 Ohm resistors have been implemented in series with the PIO lines that are used elsewhere in the design, thereby enabling their individual disconnection, should a conflict occur in your application.

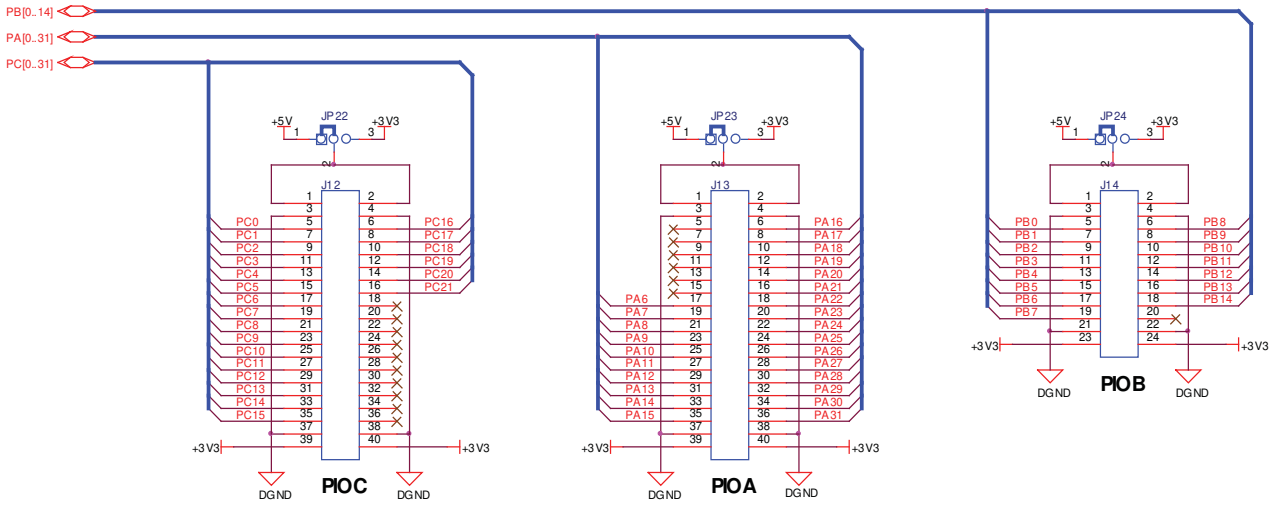
Figure 4-23. ZigBEE Interface



4.3.18 PIO Expansion

The SAM4S-EK2 product features three PIO controllers, PIOA, PIOB and PIOC, which are multiplexed with the I/O lines of the embedded peripherals. Each PIO Controller controls up to 32 lines (16 for PIOB). Expansion ports J12, J13 and J14 provide PIO lines access for customer defined usage.

Figure 4-24. PIO Expansion



Note: All PIO lines are available on these expansion connectors, except those that are used for the QTouch elements.

4.4 Configuration

This section describes the PIO usage, the jumpers, the test points and the solder drops of a SAM4S-EK2 board.

4.4.1 PIO Usage

Table 4-1. **PIO Port A Pin Assignments and Signal Descriptions**

No	I/O Line	Peripheral A	Peripheral B	Peripheral C	Extra Function	System Function	Comment	
1	PA0	PWMH0	TIOA0	A17	WKUP0		QTouch slider (left) SNS	
2	PA1	PWMH1	TIOB0	A18	WKUP1		QTouch slider (left) SNSK	
3	PA2	PWMH2	SCK0	DATRG	WKUP2		QTouch slider (middle) SNS	
4	PA3	TWD0	NPCS3				QTouch slider (middle) SNSK	
5	PA4	TWCK0	TCLK0		WKUP3		QTouch slider (right) SNS	
6	PA5	RXD0	NPCS3		WKUP4		QTouch slider (right) SNSK	
7	PA6	TXD0	PCK0				MCI card detection	
8	PA7	RTS0	PWMH3			XIN32	CLK32KHz	
9	PA8	CTS0	AD12BTRG		WKUP5	XOUT32	CLK32KHz	
10	PA9	URXD0	NPCS1	PWMFI0	WKUP6		UART receive data	
11	PA10	UTXD0	NPCS2				UART transmit data	
12	PA11	NPCS0	PWMH0		WKUP7		NPCS0# (TSC)	
13	PA12	MISO	PWMH1				MISO_TSC	ZigBEE MISO
14	PA13	MOSI	PWMH2				MOSI_TSC	ZigBEE MOSI
15	PA14	SPCK	PWMH3		WKUP8		SPCK_TSC	ZigBEE CLK
16	PA15	TF	TIOA1	PWML3	WKUP14 / PIO_DCEN1		ZigBEE SLPTR	
17	PA16	TK	TIOB1	PWML2	WKUP15 / PIO_DCEN2		IRQ_TSC	ZigBEE IRQ0
18	PA17	TD	PCK1	PWMH3	AD0		BUSY_TSC	ZigBEE IRQ1
19	PA18	RD	PCK2	A14	AD1		ZigBEE RSTN	
20	PA19	RK	PWML0	A15	AD2/ WKUP9		Blue LED (UserLED1)	
21	PA20	RF	PWML1	A16	AD3/ WKUP10		Green LED (UserLED2)	
22	PA21	RXD1	PCK1		AD8		USART RXD	
23	PA22	TXD1	NPCS3	NCS2	AD9		USART TXD	
24	PA23	SCK1	PWMH0	A19	POI_DCCLK		USART transceiver enable	
25	PA24	RTS1	PWMH1	A20	POI_DC0		USART RTS	
26	PA25	CTS1	PWMH2	A23	POI_DC1		USART CTS	
27	PA26	DCD1	TIOA2	MCDA2	POI_DC2		MCI data bit 2	
28	PA27	DTR1	TIOB2	MCDA3	POI_DC3		MCI data bit 3	
29	PA28	DSR1	TCLK1	MCCDA	POI_DC4		MCI command	

Table 4-1. **PIO Port A Pin Assignments and Signal Descriptions** (Continued)

No	I/O Line	Peripheral A	Peripheral B	Peripheral C	Extra Function	System Function	Comment
30	PA29	RI1	TCLK2	MCCK	POI_DC5		MCI clock
31	PA30	PWML2	NPCS2	MCDA0	WKUP11 / POI_DC6		MCI data bit 0
32	PA31	NPCS1	PCK2	MCDA1	POI_DC7		MCI data bit 1

Table 4-2. **PIO Port B Pin Assignments and Signal Descriptions**

No	I/O Line	Peripheral A	Peripheral B	Peripheral C	Extra Function	System Function	Comment
1	PB0	PWMH0			AD4		Microphone input
2	PB1	PWMH1			AD5		Analog input
3	PB2	URXD1	NPCS2		AD6 / WKUP12		ZigBee chip select
4	PB3	UTXD1	PCK2		AD7		User push-button 1
5	PB4	TWD1	PWMH2			TDI	JTAG data in
6	PB5	TWCK1	PWML0		WKUP13	TDO/ TRACESWO	JTAG data out
7	PB6					TMS/SWDIO	JTAG test mode select
8	PB7					TCK/SWCLK	JTAG clock
9	PB8					XOUT	CLK12MHz
10	PB9					XIN	CLK12MHz
11	PB10					DDM	USB DM
12	PB11					DDP	USB DP
13	PB12	PWML1				ERASE	Flash erase selector
14	PB13	PWML2	PCK0		DAC0		Audio Output R
15	PB14	NPCS1	PWMH3		DAC1		Audio Output L

Table 4-3. **PIO Port C Pin Assignments and Signal Descriptions**

No	I/O Line	Peripheral A	Peripheral B	Peripheral C	Extra Function	System Function	Comments
1	PC0	D0	PWML0				EBI D0
2	PC1	D1	PWML1				EBI D1
3	PC2	D2	PWML2				EBI D2
4	PC3	D3	PWML3				EBI D3
5	PC4	D4	NPCS1				EBI D4
6	PC5	D5					EBI D5
7	PC6	D6					EBI D6
8	PC7	D7					EBI D7
9	PC8	NWR0/NWE					TFT LCD write enable
10	PC9	NANDOE					NAND Flash output enable
11	PC10	NANDWE					NAND Flash write enable
12	PC11	NRD					TFT LCD read enable

Table 4-3. **PIO Port C Pin Assignments and Signal Descriptions** (Continued)

No	I/O Line	Peripheral A	Peripheral B	Peripheral C	Extra Function	System Function	Comments
13	PC12	NCS3			AD12		User push-button 2
14	PC13	NWAIT	PWML0		AD10		LCD backlight control
15	PC14	NCS0					NAND Flash chip select
16	PC15	NCS1	PWML1		AD11		TFT LCD chip select
17	PC16	A21/NANDALE					NAND Flash ALE
18	PC17	A22/NANDCLE					NAND Flash CLE
19	PC18	A0/NBS0	PWMH0			RDYBSY	NAND Flash RDY/BSY
20	PC19	A1	PWMH1				TFT LCD RegSel
21	PC20	A2	PWMH2				Red LED (Power)
22	PC21	A3	PWMH3				USB Vbus detection
23	PC22	A4	PWML3				QTouch valid button SNS
24	PC23	A5	TIOA3				QTouch valid button SNSK
25	PC24	A6	TIOB3				QTouch up button SNS
26	PC25	A7	TCLK3				QTouch up button SNSK
27	PC26	A8	TIOA4				QTouch down button SNS
28	PC27	A9	TIOB4				QTouch down button SNSK
29	PC28	A10	TCLK4		AD13		QTouch left button SNS
30	PC29	A11	TIOA5		AD14		QTouch left button SNSK
31	PC30	A12	TIOB5				QTouch right button SNS
32	PC31	A13	TCLK5				QTouch right button SNSK