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Features

- **Complete Touchscreen Module:**
    - **Projected Capacitive Multi Touch Controller**
    - **4.3in LCD**
    - **4 Capacitive "Navigation" Keys**
    - **200 bytes non-volatile serial EEPROM**
- **Touch:**
    - **Atmel maXTouch mXT224E Touch Controller**
    - **Supports up to 10 touches**
- **Display:**
    - **Shelly SCA04310-BFN-LNN (A407) 4.3in LCD**
    - **480x272 resolution**
    - **20 ms response time**
    - **White LED backlight**
- **Navigation Keys:**
    - **Atmel AT42QT1070**
- **Cover Panel:**
    - **1.2mm Soda Lime Glass**
    - **Optional 0.7mm Gorilla Glass™**

PDA TM4300: 4.3in PCAP Touch Module – ARM EK Configuration

1211-4-5

Contents

1   Module Overview

1.1   PCB Connections

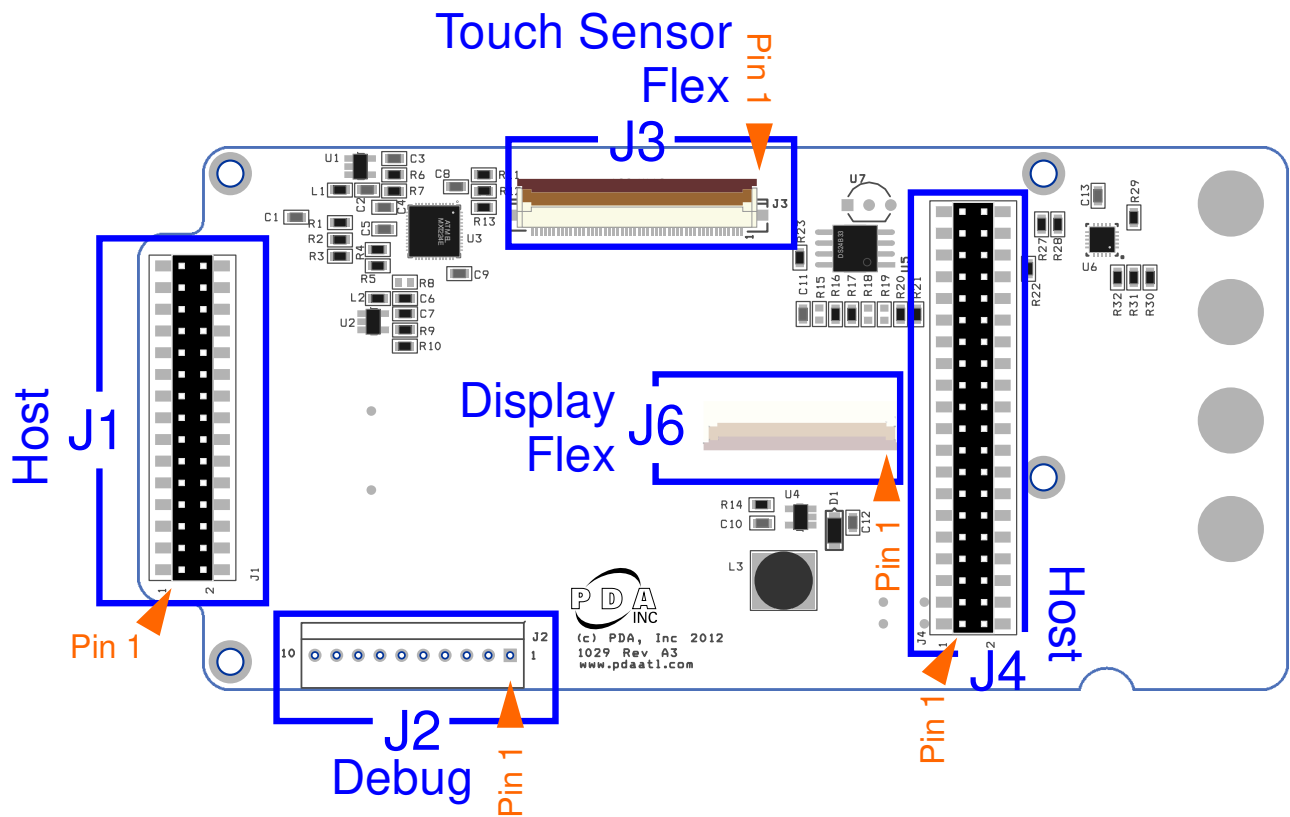**Figure 1 - PCB Connectors**

NOTE: Connector J6 is on the bottom side of the PCB.

The following notations are used for pin descriptions:

MXT	maXTouch touchscreen	QT	QTouch Button Controller
EE	Serial EEPROM	LCD	LCD Panel
I	Input only	OD	Open drain output
O	Output only, push-pull	P	Ground or power

1.2   Host Connector J1

Connector J1 connects to the host and carries signals between the host and (1) the MaXTouch Touch Controller, (2) the QTouch Button Controller and (3) LCD Panel.

Pin	Type	Description	MXT	LCD	QT	EE
1	-	*N/C*				
2	P	GND	•			
3	-	*N/C*				
4	P	GND				
5	O	~MXT_CHG	•			
6	O	~QT_CHG			•	
7	I	I^{2}C SCL	•		•	
8	I/O	I^{2}C SDA	•		•	
9	P	GND				
10	I	G7		•		
11	P	GND				
12	I	G5		•		
13	P	GND				
14	I	G6		•		
15	P	GND				

Pin	Type	Description	MXT	LCD	QT	EE
16	I	G4		•		
17	P	GND				
18	I	B0		•		
19	I	B1		•		
20	I	B2		•		
21	I	B3		•		
22	I	B4		•		
23	I	B5		•		
24	I	B6		•		
25	I	B7		•		
26	I	G0		•		
27	I	G1		•		
28	I	G2		•		
29	I	G3		•		
30	P	GND				

1.3   Debug Connector J2

Connector J2 carries signals used to debug the MaXTouch Touch Controller and QTouch Button Controller.

Pin	Type	Description	MXT	QT
1	P	+5Vdc		
2	O	~QT_CHG		•
3	O	~MXT_CHG	•	
4	-	N/C		
5	I	I^{2}C SDA	•	•

Pin	Type	Description	MXT	QT
6	I/O	I^{2}C SCL	•	•
7	-	*N/C*		
8	P	GND		
9	O	DBG DATA	•	
10	O	DBG CLK	•	

1.4 Touch Sensor Flex Connector J3

Connector J3 connects to the touch sensor flex and carries signals used by the maXTouch controller to detect input on the touch sensor.

Pin	Type	Description
1	P	GND
2	P	GND
3	I/O	Y10
4	I/O	Y9
5	I/O	Y8
6	I/O	Y7
7	I/O	Y6
8	I/O	Y5
9	I/O	Y4
10	I/O	Y3
11	I/O	Y2
12	I/O	Y1
13	I/O	Y0
14	P	GND
15	P	GND
16	I/O	X0
17	I/O	X1
18	I/O	X2
19	I/O	X3
20	I/O	X4
21	I/O	X5
22	I/O	X6
23	I/O	X7
24	I/O	X8
25	I/O	X9

Pin	Type	Description
26	I/O	X9 (Duplicate)
27	I/O	X10
28	I/O	X11
29	I/O	X12
30	I/O	X13
31	I/O	X14
32	I/O	X15
33	I/O	X16
34	I/O	X17
35	I/O	X18
36	P	GND
37	P	GND
38	I/O	Y0
39	I/O	Y1
40	I/O	Y2
41	I/O	Y3
42	I/O	Y4
43	I/O	Y5
44	I/O	Y6
45	I/O	Y7
46	I/O	Y8
47	I/O	Y9
48	I/O	Y10
49	P	GND
50	P	GND

1.5 Host Connector J4

Connector J4 connects to the host and carries signals between the host and (1) the LCD Panel and (2) serial EEPROM.

Pin	Type	Description	MXT	LCD	QT	EE
1	P	+5Vdc				
2	P	GND				
3	P	+5Vdc				
4	P	GND				
5	I	R0		•		
6	I	R1		•		
7	I	R2		•		
8	I	R3		•		
9	I	R4		•		
10	I	R5		•		
11	I	R6		•		
12	I	R7		•		
13	P	GND				
14	P	GND				
15	I	DISP (Display Enable)		•		
16	I	Backlight PWM		•		
17	I	VSYNC		•		
18	I	HSYNC		•		
19	I	DE		•		
20	I	PCLK		•		

Pin	Type	Description	MXT	LCD	QT	EE
21	P	GND				
22	P	GND				
23	-	*N/C*				
24	-	*N/C*				
25	-	*N/C*				
26	-	*N/C*				
27	-	*N/C*				
28	I/O	One-Wire Interface				•
29	P	GND				
30	P	GND				
31	-	*N/C*				
32	-	*N/C*				
33	-	*N/C*				
34	-	*N/C*				
35	-	*N/C*				
36	O	Module Presence Detect				
37	-	*N/C*				
38	-	*N/C*				
39	P	GND				
40	P	GND				

1.6 Display Flex Connector J6

Connector J6 connects to the LCD panel flex and carries signals between the host and the LCD Panel.
Note: J6 is located on the back side of the PCB.

Pin	Type	Description
1	P	LED-
2	P	LED+
3	P	GND
4	P	+3.3Vdc
5	O	R0
6	O	R1
7	O	R2
8	O	R3
9	O	R4
10	O	R5
11	O	R6
12	O	R7
13	O	G0
14	O	G1
15	O	G2
16	O	G3
17	O	G4
18	O	G5
19	O	G6
20	O	G7

Pin	Type	Description
21	O	B0
22	O	B1
23	O	B2
24	O	B3
25	O	B4
26	O	B5
27	O	B6
28	O	B7
29	P	GND
30	O	PCLK
31	O	DISP
32	O	HSYNC
33	O	VSYNC
34	O	DE
35	-	*N/C*
36	P	GND
37	-	*N/C*
38	-	*N/C*
39	-	*N/C*
40	-	*N/C*

2   Overview of the 4.3in PCAP Touch Module – ARM EK Configuration

2.1   Introduction

The 4.3in PCAP Touch Module – ARM EK Configuration is a touchscreen module offering best-in-class projected capacitance multi-touch functionality combined with a 4.3in LCD panel.   The module is configured for development and evaluation with several Atmel ARM-based EK solutions as well as development and integration with a custom host system.

For convenience, this module features host interface connectors (J1 and J4) positioned for direct installation on Atmel ARM-based EK boards.

As shown in Figure 2 below, the module provides host access to several sub-system components to maximize effective integration.

PDA 4.3in PCAP Touch Module - ARM EK Configuration
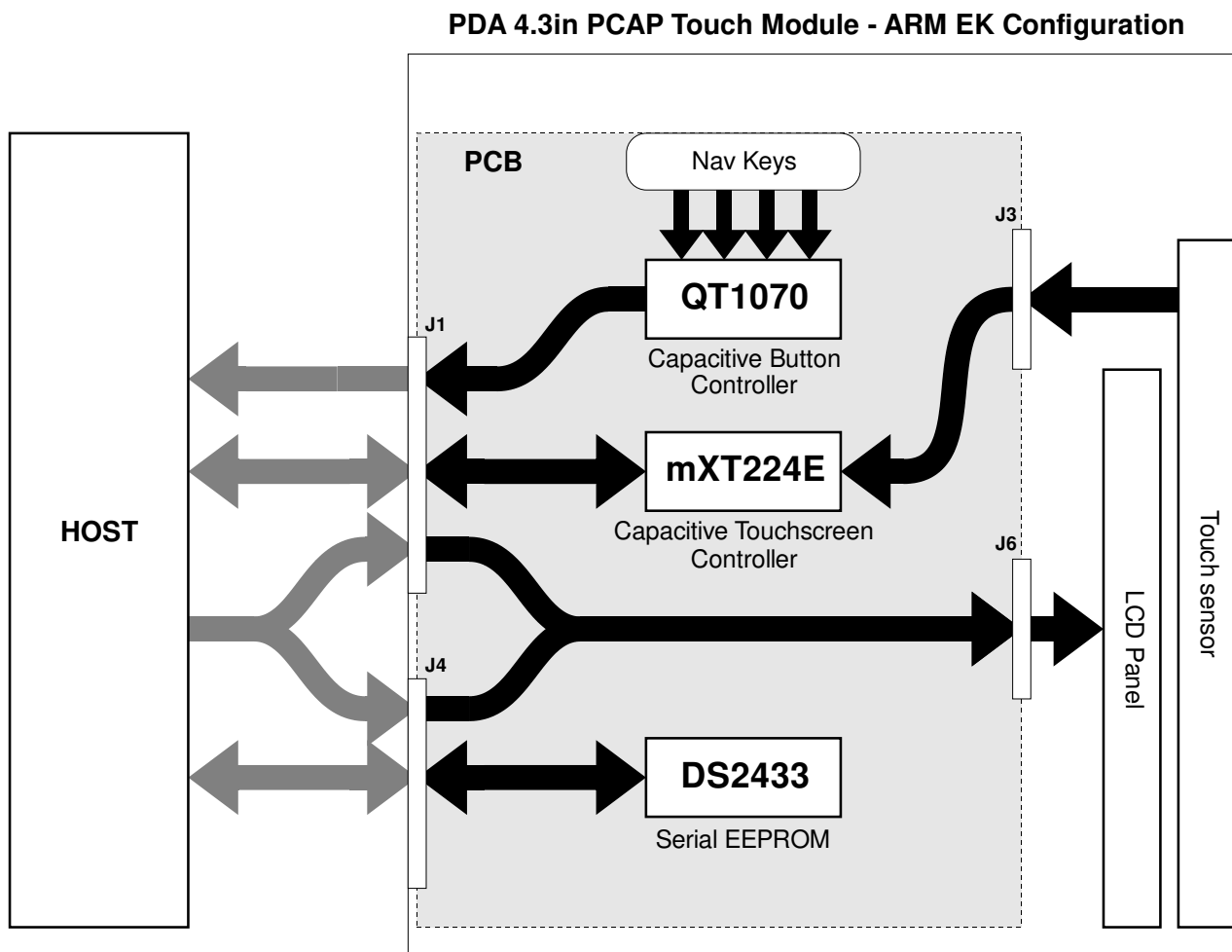
Figure 2 - Functional Block Diagram

2.2 Understanding Unfamiliar Concepts

Throughout this document, the functionality of the module sub-system will be outlined and summarized. However, the user is encouraged to refer to the resources and documents below in order to gain a more thorough understanding of each sub-system.

• For a basic overview of I^{2}C communication, refer to Section 5 of this document
• Shelly SCA04310-BFN-LNN (A407) (www.shellyinc.com)
• Atmel maXTouch mXT224E Datasheet (www.atmel.com)
• Atmel QTouch QT1070 Datasheet (www.atmel.com)
• Maxim DS24B33 Datasheet (www.maximintegrated.com)

In addition, when developing or evaluating with the Atmel ARM-based EK's, it is recommended that the user visit www.at91.com which contains a broad range of resources for the EK's and the ARM devices they feature.

2.3 LCD Panel

The module provides the host with a direct connection from the host (Connector J1 and J4) to the LCD panel interface (Connector J6). Aside from generating supply voltages for the LED backlight and providing backlight control to the host, no display panel control is performed by the module.

2.4 maXTouch Capacitive Touchscreen Controller

The module touch screen interface is based on the Atmel maXTouch mXT224E Touch Controller.

The touch controller scans the touch sensor and will signal the host with an active low interrupt signal (Connector J1-5 ~CHG) when new touch data is available. Data communication with the maXTouch controller is performed over a shared I^{2}C interface (Connector J1-7 SCL and J1-8 SDA). The I^{2}C address of the touch controller can be configured by populating R5 or R8 (shown below in Figure 3) according to Table 2-1 below. The PCB ships with R5 populated – thus the I^{2}C address is set to 0x4A by default.

NOTE: Pull-up resistors for the I^{2}C SCL and SDA lines are located at R3 and R2 respectively. A pull-up resistor for the maXTouch ~CHG interrupt signal is located at R4.
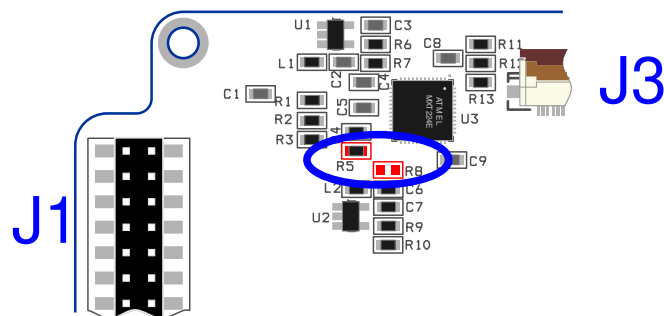

Figure 3 - Touch Controller I^{2}C Address Selection

Table 2-1 - Touch Controller I^{2}C Address Selection

R5	R8	I^{2}C Address
0 Ω	DNP	0x4A
DNP	0 Ω	0x4B

Note: 0x4A is the default I^{2}C address

2.4.1 maXTouch Controller Interface

Details of the maXTouch communication protocol are beyond the scope of this document. However information is provided below to facilitate evaluation and initial development.

The module is pre-loaded with a configuration already optimized for this touch sensor and panel, so the developer need only focus on interfacing with the device. When developing the maXTouch controller interface during evaluation and host development, care should be taken to avoid changing the maXTouch configuration or committing changes to NV storage on the maXTouch controller.

To get started with host interface development, the user is *strongly* encouraged to leverage existing code available from the resources outlined in the following sections

2.4.1.1   Atmel Software Framework

The Atmel Software Framework (asf.atmel.com) contains examples of code for interfacing with devices in the maXTouch family of touch controllers. The capabilities of various maXTouch devices may differ, but the basic communication protocol is common and can be applied to this module.

2.4.1.2   Linux Kernel / Android

The Linux Kernel (www.kernel.org) has included basic support for maXTouch touch devices since version 2.6.36. The mainline driver has undergone considerable evolution since then.

In addition, Atmel maintains patches (www.github.com/atmel-maxtouch/linux) which provide numerous out-of-cycle improvements to the mainline Linux Kernel driver.

2.5 QTouch Capacitive Button Controller

The module "nav key" interface is based on the Atmel QT1070 7-Channel Capacitive Sensor Driver.

The button controller scans the 4 capacitive nav keys (K1, K2, K3 and K4) and will signal the host with an active low interrupt signal (Connector J1-6 ~CHG) when a touch event has occurred. Data communication with the QT1070 controller is performed over a shared I^{2}C interface (Connector J1-7 SCL and J1-8 SDA). The I^{2}C address of the button controller is 0x1B and cannot be changed.

NOTE: Pull-up resistors for the I^{2}C SCL and SDA lines are located at R3 and R2 respectively. A pull-up resistor for the QTouch ~CHG interrupt signal is located at R27.

2.5.1 QTouch Controller Interface

Details of the QTouch communication protocol are beyond the scope of this document. The user is encouraged to review the QT1070 Datasheet (www.atmel.com).

2.6 Serial EEPROM

The module includes a DS24B33 Serial EEPROM providing 512 bytes of non-volatile storage. Data communication with the EEPROM is performed over a One-Wire Interface. The EEPROM is not used by another

subsystem on the touch module and can be freely used by the host system for any purpose.   For example, Atmel ARM-based EK's running Linux or Android operating systems use the pre-programmed contents of the EEPROM to identify this module type.

NOTE: The user should take care when overwriting the pre-programmed EEPROM contents. As noted above, certain builds of Linux or Android targeted for the Atmel ARM-based EKs may no longer recognize the module.   The user is advised to backup the EEPROM contents before overwriting.

The serial EEPROM communicates via a one-wire interface (Connector J1-28).   Refer to the DS24B33 Datasheet (www.maximintegrated.com) for details.

3   Getting Started - Atmel ARM-based EK

This module was designed to install on a variety of Atmel ARM-based EK's.   This provides perhaps the fastest way to evaluate the performance of the touchscreen and display using a familiar, full-featured OS.   The following sections will outline the process of installing the module on an Atmel AT91SAM9X35-EK running Android.

3.1   Hardware Connection

The module interfaces with the EK board via the two large dual-row headers, J1 and J4.   Connectors J1 and J4 on the module PCB connect with J21 and J22 respectively on the EK board (AT91SAM9X5-EK in this example).   Disconnect power and USB from the EK board (and remove any other display module) before installing the touch module as shown below in Figure 4.
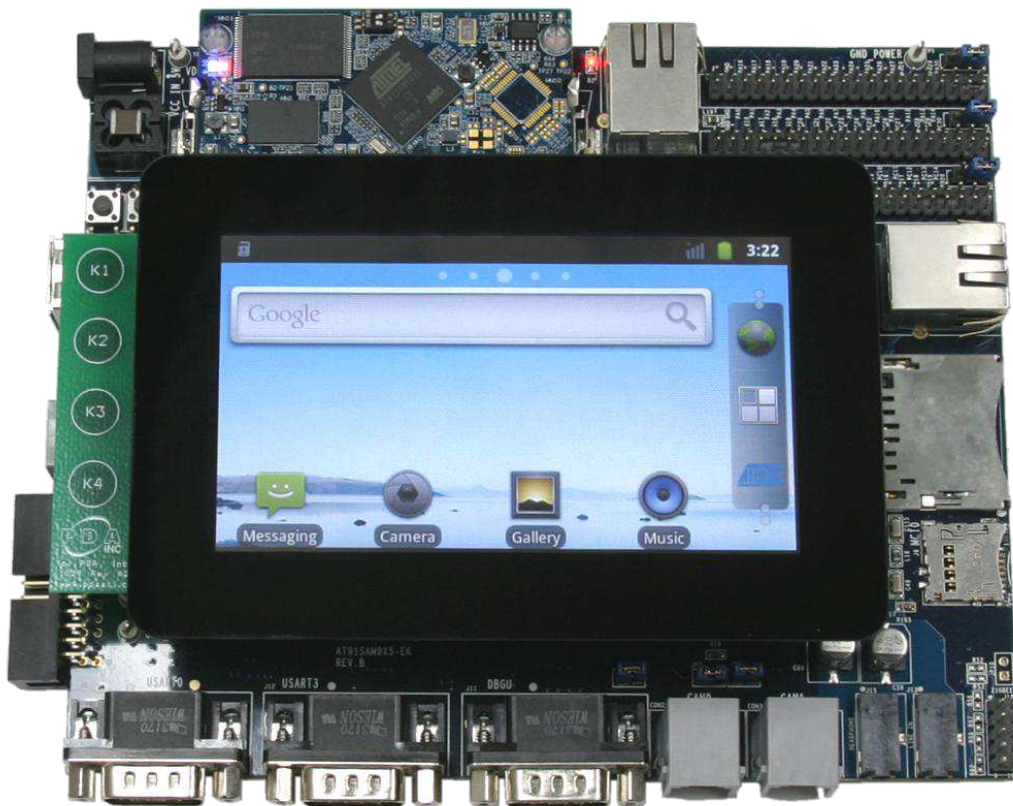
Figure 4 – Connecting the module to the EK

3.2   Loading an OS Image

In order demonstrate the complete functionality of the module, an OS image has been prepared that includes support for all of the subsystems.

3.2.1 Installing SAM-BA

Before the OS image can be loaded, you must first ensure that the Atmel SAM Boot Assistant (SAM-BA) utility is installed.   The SAM-BA software can be found at http://www.atmel.com/atmelsam-bain-systemprogrammer.aspx for both Windows and Linux platforms.

1. Remove power from the EK (J4) and remove any USB cables from the mini USB connector (J19)
2. Run the installation for the SAM-BA utility and following the installation steps until setup is complete.
3. On the Computer Module (CM) board, disable the NAND flash chip-select.   (Refer to schematic for the particular CM used.   For example, on the Embest 9X35 CM, SW1-1 should be switched OFF to disable NAND flash)
4. Connect power to the EK (J4) and connect a USB cable from the mini-USB connector (J19) to the computer.
5. After the USB device is recognized, a driver may be required.   Point to the "drv" subfolder where SAM-BA was installed.   For example, "C:\Program Files\Atmel Corporation\SAM-BA\drv"

3.2.2 Installing the OS Image

Once the SAM-BA utility has been installed, the OS image can be loaded onto the EK.   Download the Android OS image from http://www.pdaatl.com/modules/4.3in/sam9x35_android.zip and unzip to a working folder.   Follow the procedure below to load the OS image onto the EK:

1. Remove power from the EK (J4) and remove any USB cables from the mini USB connector (J19)
2. On the Computer Module (CM) board, disable the NAND flash chip-select.   (Refer to schematic for the particular CM used.   For example, on the Embest 9X35 CM, SW1-1 should be switched OFF to disable NAND flash)
3. Connect power to the EK (J4) and connect a USB cable from the mini-USB connector (J19) to the computer.
4. On the CM board, enable the NAND flash chip-select.   (Refer to schematic for the particular CM used. For example, on the Embest 9X35 CM, SW1-1 should be switched ON to enable NAND flash.)
5. Run the "at91SAM9x5.bat" file in the folder where the ZIP file was extracted.   This will execute a script causing SAM-BA to download the various OS images to the EK.   The process can take 1 or 2 minutes.
6. When the download process completes, check the "logfile.log" file.   The last line of the log file should read:

```
-I- === Successful !!! Now reboot the board  ===
```

3.2.3 Using the Touch Module

Reboot the EK and wait for the OS to startup.   The display should show several different progress screens – initially the Atmel logo, followed by the Android start screen, finally displaying the Android home screen.

When running this Android OS image, the navigation keys function as follows:

Table 3-1 - Navigation Key Function (Android)

Key	Navigation Function
K1	⬅ Back
K2	▤ Menu
K3	⌂ Home
K4	⏻ Power / Sleep

3.2.4 Using the Touch Module

For effective evaluation of the module – the touch sensor and the LCD panel in particular – the user is encouraged to try the following Android apps available from Google Play:

TouchTest by Moonblink
Dotty by Gerry Steele
Multitouch Visible Test by Battery Powered Games
Screen Test by Amberfog

4   Specifications

For complete specifications, refer to the datasheets listed in section 2.2 for the various sub-system components outlined in sections 2.3 through 2.6.

4.1   Mechanical Specifications

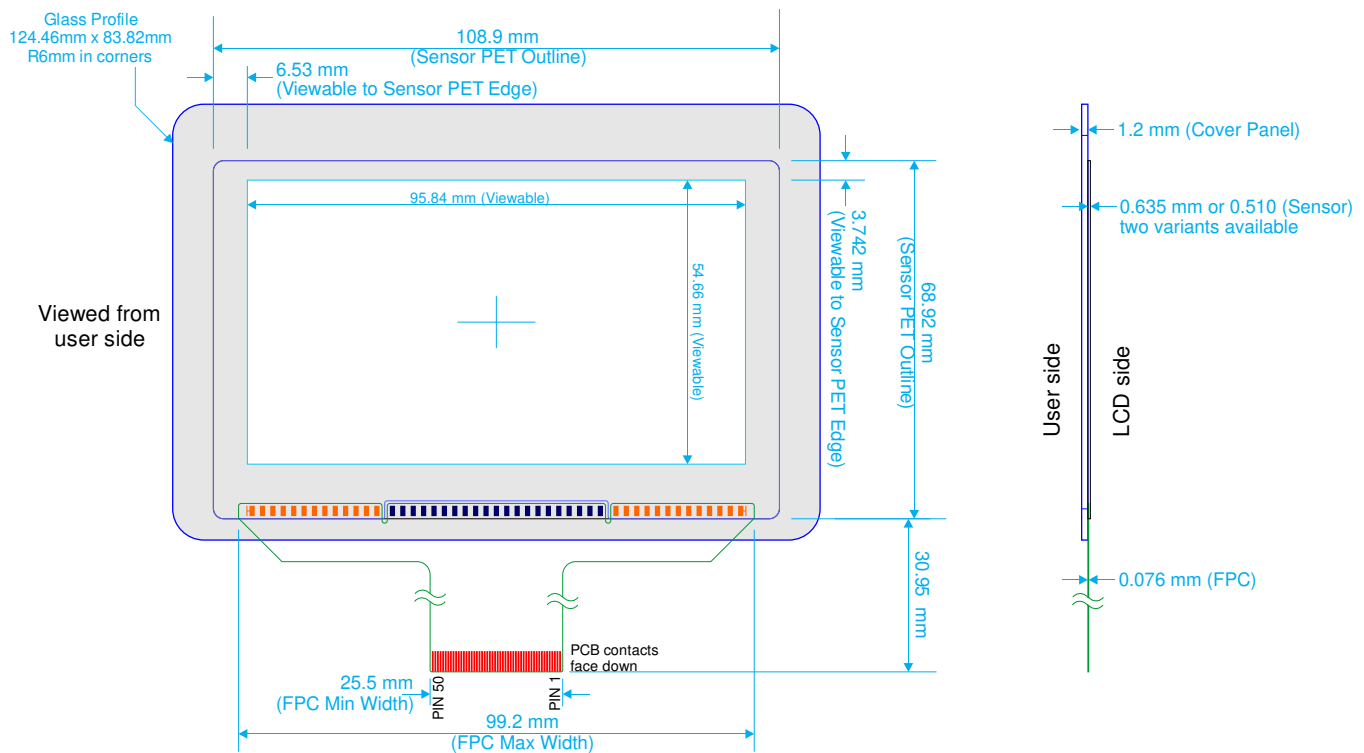Drawings and CAD models available upon request.

Figure 5 - Sensor Only Dimensions

Sensor (P/N: 21-00002-A0) may be purchased individually.
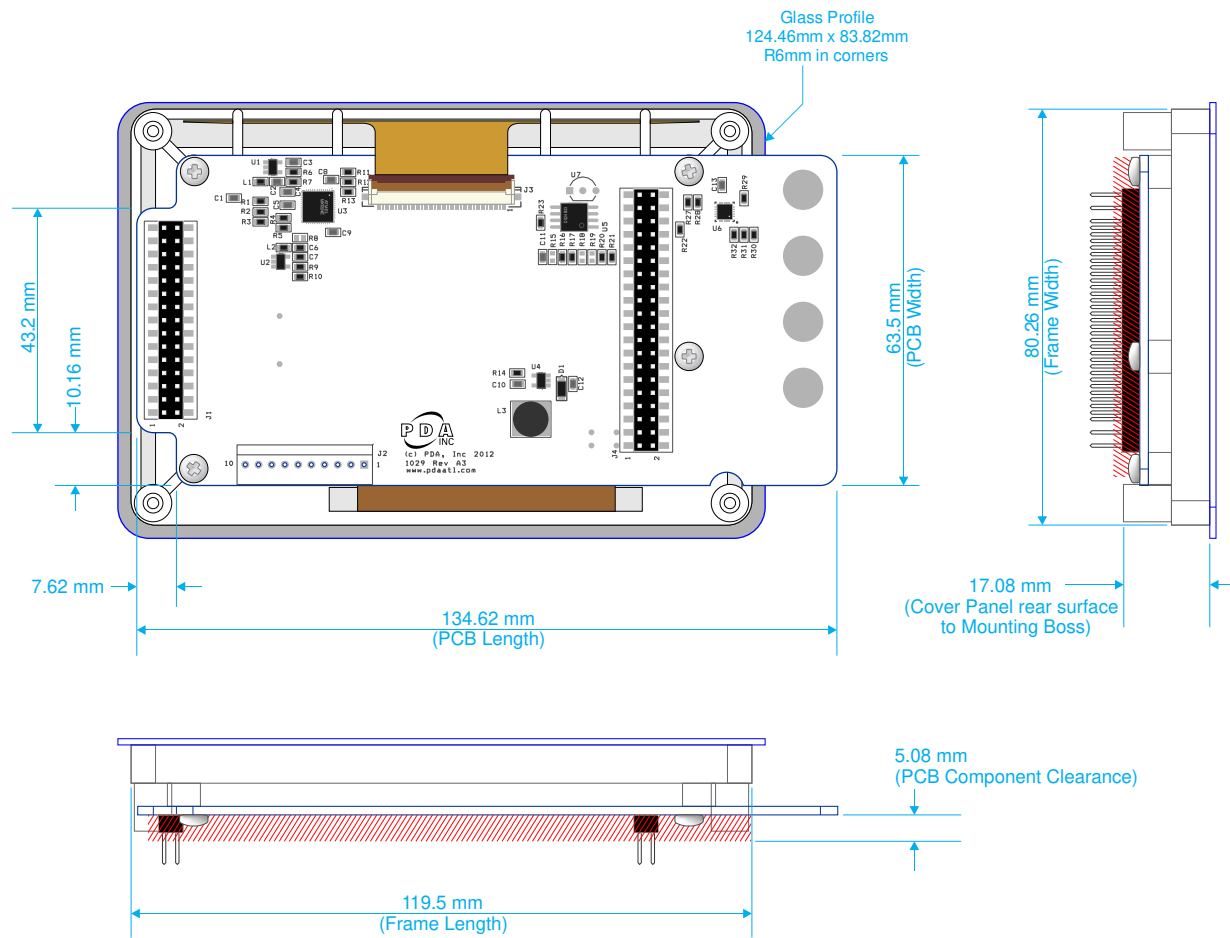Minimum order quantities apply. Contact PDA for details.

Figure 6 – Module Dimensions

4.2 Absolute Maximum Specifications

Parameter	Value
Operating temp	0°C to + 70°C
Storage temp	-40°C to + 85°C
Vdd	-0.5 to +6V
Max continuous pin current, any control or drive pin	±40 mA
Voltage forced onto any pin	-0.5V to (Vdd + 0.5) Volts

CAUTION: Stresses beyond those listed under *Absolute Maximum Specifications* may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or other conditions beyond those indicated in the operational sections of this specification are not implied. Exposure to absolute maximum specification conditions for extended periods may affect device reliability.

4.3   Recommended Operating Conditions

Parameter	Value
Vin	5.0V ±5 percent
Supply ripple + noise	±20 mV

4.4   DC Specifications

Vin = 5.0V, Vdd=3.3VdcTa = recommended range, unless otherwise noted

Parameter	Description	Min	Typ	Max	Units	Notes
V_{IL}	Low input logic level	- 0.5	–	0.3 Vdd	V	1.8V <Vdd <3.3V
V_{HL}	High input logic level	0.7 Vdd	–	Vdd + 0.5	V	1.8V <Vdd <3.3V
V_{OL}	Low output voltage	–	–	0.2Vdd	V	
V_{OH}	High output voltage	0.8Vdd	–	–	V	
I_{IL}	Input leakage current	–	–	1	µA	

4.5   I2C-compatible Bus Specifications

Parameter	Operation
Address	0x4A or 0x4B
Maximum bus speed (SCL)	400 kHz
I2C Specification	Version 2.1

4.6   Power Consumption

| Vdd (V)	Mode	Idd (mA)
3.3Vdc	mXT224E in Free Run, LCD backlight on maximum intensity	200

4.7   Part Number

Part Number	Description
90-00002-A0	4.3" Touchscreen Module For Atmel ARM EK

5 I2C Basics (I2C-compatible Operation)

5.1 Interface Bus

The device communicates with the host over an I^2C-compatible bus, in accordance with version 2.1 of the I^2C specification. The following sections give an overview of the bus; more detailed information is available from www.i2C-bus.org. Devices are connected to the I^2C-compatible bus as shown in Figure 7 both bus lines are connected to Vdd via pull-up resistors. The bus drivers of all I^2C-compatible devices must be open-drain type. This implements a wired "AND" function that allows any and all devices to drive the bus, one at a time. A low level on the bus is generated when a device outputs a zero.

Figure 7. I^2C-compatible Interface Bus
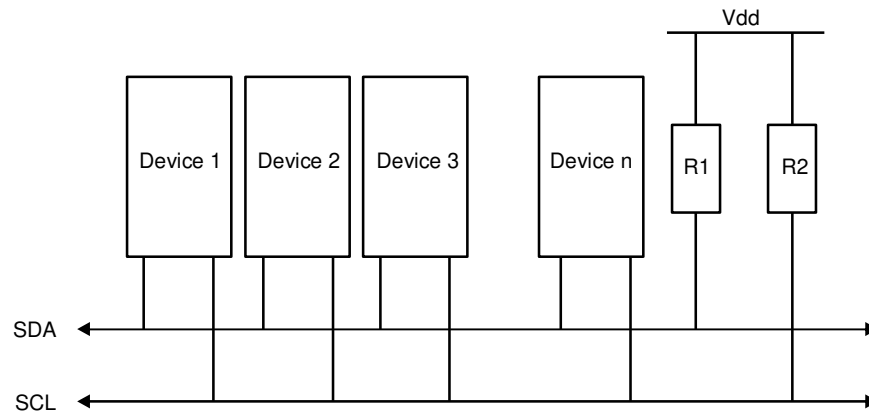
5.2 Transferring Data Bits

Each data bit transferred on the bus is accompanied by a pulse on the clock line. The level of the data line must be stable when the clock line is high; the only exception to this rule is for generating START and STOP conditions.

Figure 8.   Data Transfer
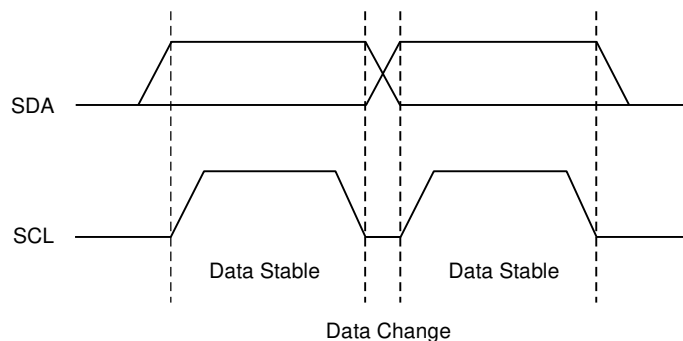
5.3 START and STOP Conditions

The host initiates and terminates a data transmission. The transmission is initiated when the host issues a START condition on the bus, and is terminated when the host issues a STOP condition. Between the START and STOP conditions, the bus is considered busy. As shown in Figure 9 START and STOP conditions are signaled by changing the level of the SDA line when the SCL line is high.

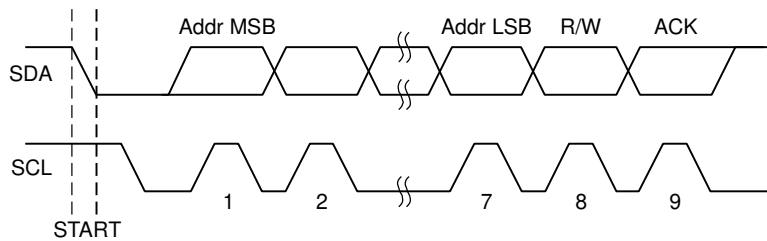**Figure 9.   START and STOP Conditions**
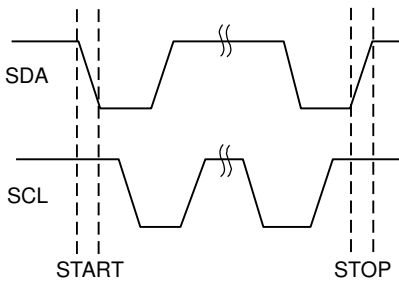
5.4   Address Byte Format

All address bytes are 9 bits long. They consist of 7 address bits, one READ/WRITE control bit and an acknowledge bit. If the READ/WRITE bit is set, a read operation is performed. Otherwise a write operation is performed. An address byte consisting of a slave address and a READ or a WRITE bit is called SLA+R or SLA+W, respectively. When the device recognizes that it is being addressed, it acknowledges by pulling SDA low in the ninth SCL (ACK) cycle.

The most significant bit of the address byte is transmitted first.

Figure 10.   Address Byte Format

5.5   Data Byte Format

All data bytes are 9 bits long, consisting of 8 data bits and an acknowledge bit. During a data transfer, the host generates the clock and the START and STOP conditions. The slave device is responsible for acknowledging the reception. An acknowledge (ACK) is signaled by the slave device pulling the SDA line low during the ninth SCL cycle. If the slave device leaves the SDA line high, a NACK is signaled.

Figure 11.   Data Byte Format
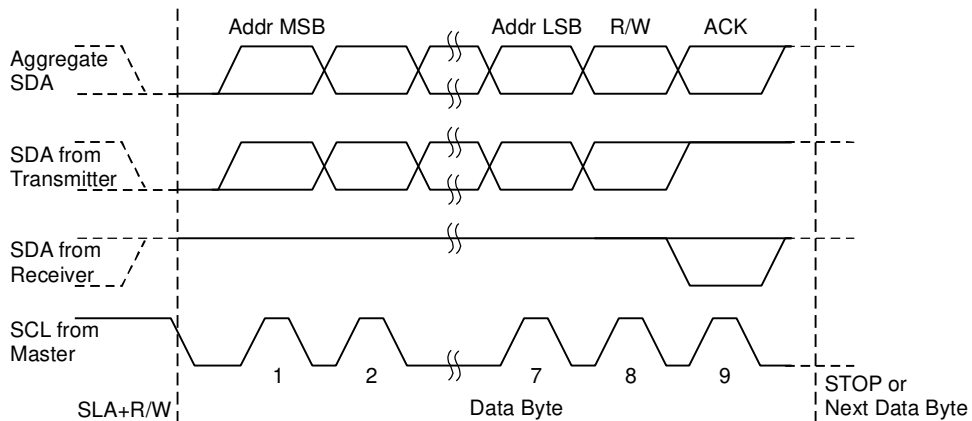
5.6 Combining Address and Data Bytes into a Transmission

A transmission consists of a START condition, an SLA+R or SLA+W, one or more data bytes and a STOP condition. The wired "ANDing" of the SCL line is used to implement handshaking between the host and the device. The device extends the SCL low period by pulling the SCL line low whenever it needs extra time for processing between the data transmissions.

Figure 12 shows a typical data transmission. Note that several data bytes can be transmitted between the SLA+R or SLA+W and the STOP.

Figure 12.   Byte Transmission
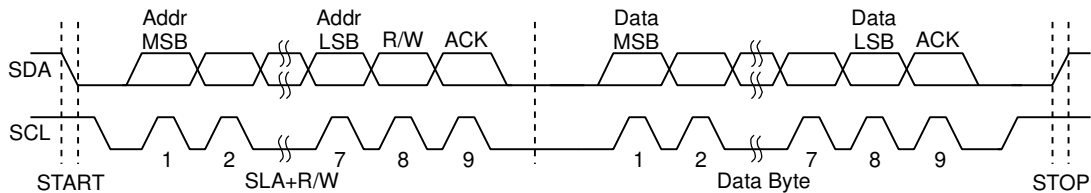
6 Revision History

Revision No.	History
Rev 1209-0-1 – Sept 2012	Initial Draft (unreleased)
Rev 1209-1-2 – Sept 2012	Preliminary Draft (limited release)
Rev 1210-2-3 – Oct 2012	Remove references to gesture support – not available on this module.
Rev 1210-3-4 – Oct 19, 2012	Correct swapped I^2C clock and data signals in Debug Connector J2 pinout table.
Rev 1211-4-5 – Nov 21, 2012	Add notes to Figure 5 regarding sensor orientation and pin 1 location. Add notes to Figure 1 identifying connectors and pin 1 locations.

7 Notes

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