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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™ mXT336S Touch Controller**
    - **Supports up to 10 touches**
- **Display:**
    - **480x272 resolution**
    - **Himax HX8257-A driver IC**
    - **20 ms response time**
    - **White LED backlight**
- **Navigation Keys:**
    - **Atmel AT42QT1070 QTouch™ Button Sensor IC**
- **Cover Panel:**
    - **1.1mm Soda Lime Glass**

PDA TM4301: 4.3in PCAP Touch Module

1403-2-4

Visit http://www.pdaatl.com/tm4301
for the latest information on the TM4301

Contents

1　Module Overview

1.1　PCB Connections

Figure 1 - PCB Connectors

NOTE: Connector J7 is on the bottom side of the PCB.
NOTE: Insert flex in Connector J5 with contacts facing DOWN.

The following notations are used for pin descriptions:

I	Input only	OD	Open drain output
O	Output only, push-pull	P	Ground or power

MXT	maXTouch touchscreen	QT	QTouch Button Controller
EE	Serial EEPROM	LCD	LCD Panel

NOTE: Inputs and output are defined from the standpoint of the Touch Module.

1.2   UNUSED - Alternate Touch Sensor Interface J1

NOTE: Connector J1 is not populated or used on the TM4301 Module.

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   Host Connector J3

Connector J3 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.

NOTE: J3 (and J4) should <u>not</u> be used when J5 is in use.

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	LCD_DATA_15 / G7		•		
11	P	GND				
12	I	LCD_DATA_13 / G5		•		
13	P	GND				
14	I	LCD_DATA_14 / G6		•		
15	P	GND				

Pin	Type	Description	MXT	LCD	QT	EE
16	I	LCD_DATA_12 / G4		•		
17	P	GND				
18	I	LCD_DATA_0 / B0		•		
19	I	LCD_DATA_1 / B1		•		
20	I	LCD_DATA_2 / B2		•		
21	I	LCD_DATA_3 / B3		•		
22	I	LCD_DATA_4 / B4		•		
23	I	LCD_DATA_5 / B5		•		
24	I	LCD_DATA_6 / B6		•		
25	I	LCD_DATA_7 / B7		•		
26	I	LCD_DATA_8 / G0		•		
27	I	LCD_DATA_9 / G1		•		
28	I	LCD_DATA_10 / G2		•		
29	I	LCD_DATA_11 / G3		•		
30	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.

NOTE: J4 (and J3) should <u>not</u> be used when J5 is in use.

Pin	Type	Description	MXT	LCD	QT	EE
1	P	+5Vdc				
2	P	GND				
3	P	+5Vdc				
4	P	GND				
5	I	LCD_DATA_16 / R0		•		
6	I	LCD_DATA_17 / R1		•		
7	I	LCD_DATA_18 / R2		•		
8	I	LCD_DATA_19 / R3		•		
9	I	LCD_DATA_20 / R4		•		
10	I	LCD_DATA_21 / R5		•		
11	I	LCD_DATA_22 / R6		•		
12	I	LCD_DATA_23 / 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	O	MISO				
32	I	MOSI				
33	I	SCK				
34	I	~SS				
35	-	*N/C*				
36	O	Module Presence Detect				
37	-	*N/C*				
38	-	*N/C*				
39	P	GND				
40	P	GND				

1.6 Host Interface (Combined) J5

Connector J5 connects to the host and carries the combined signals of J3 and J4. It provides an alternate interface between the host and (1) the MaXTouch Touch Controller, (2) the QTouch Button Controller, (3) LCD Panel, and (4) serial EEPROM.

Suggested Flex:
   Manufacturer P/N: Wurth Electronics #687 650 100 002
   Description: 0.5mm pitch 50 position FFC, Length 100mm

Flex should be inserted Connector J5 with contacts facing DOWN.

NOTE: J5 should <u>not</u> be used when J3 and J4 are in use.

Pin	Type	Description	MXT	LCD	QT	EE
1	I/O	One-Wire Interface				•
2	P	GND				
3	I	LCD_DATA_0 / B0		•		
4	I	LCD_DATA_1 / B1		•		
5	I	LCD_DATA_2 / B2		•		
6	I	LCD_DATA_3 / B3		•		
7	P	GND				
8	I	LCD_DATA_4 / B4		•		
9	I	LCD_DATA_5 / B5		•		
10	I	LCD_DATA_6 / B6		•		
11	I	LCD_DATA_7 / B7		•		
12	P	GND				
13	I	LCD_DATA_8 / G0		•		
14	I	LCD_DATA_9 / G1		•		
15	I	LCD_DATA_10 / G2		•		
16	I	LCD_DATA_11 / G3		•		
17	P	GND				
18	I	LCD_DATA_12 / G4		•		
19	I	LCD_DATA_13 / G5		•		
20	I	LCD_DATA_14 / G6		•		
21	I	LCD_DATA_15 / G7		•		
22	P	GND				
23	I	LCD_DATA_16 / R0		•		
24	I	LCD_DATA_17 / R1		•		
25	I	LCD_DATA_18 / R2		•		

Pin	Type	Description	MXT	LCD	QT	EE
26	I	LCD_DATA_19 / R3		•		
27	P	GND				
28	I	LCD_DATA_20 / R4		•		
29	I	LCD_DATA_21 / R5		•		
30	I	LCD_DATA_22 / R6		•		
31	I	LCD_DATA_23 / R7		•		
32	P	GND				
33	I	PCLK		•		
34	I	VSYNC		•		
35	I	HSYNC		•		
36	I	DE		•		
37	I	SCK				
38	I	MOSI				
39	O	MISO				
40	I	~SS				
41	I	DISP		•		
42	I	I^{2}C SDA	•		•	
43	I/O	I^{2}C SCL	•		•	
44	O	~MXT_CHG	•			
45	O	~QT_CHG			•	
46	I	LCD_PWM		•		
47	I	~RESET	•		•	
48	P	+5Vdc				
49	P	+5Vdc				
50	P	GND				

1.7 Display Flex Connector J7

Connector J7 connects to the LCD panel flex and carries signals between the host and the LCD Panel.
Note: J7 is located on the back side of the PCB.

Pin	Type	Description		Pin	Type	Description
1	P	LED-		21	O	LCD_DATA_0 / B0
2	P	LED+		22	O	LCD_DATA_1 / B1
3	P	GND		23	O	LCD_DATA_2 / B2
4	P	+3.3Vdc		24	O	LCD_DATA_3 / B3
5	O	LCD_DATA_16 / R0		25	O	LCD_DATA_4 / B4
6	O	LCD_DATA_17 / R1		26	O	LCD_DATA_5 / B5
7	O	LCD_DATA_18 / R2		27	O	LCD_DATA_6 / B6
8	O	LCD_DATA_19 / R3		28	O	LCD_DATA_7 / B7
9	O	LCD_DATA_20 / R4		29	P	GND
10	O	LCD_DATA_21 / R5		30	O	PCLK
11	O	LCD_DATA_22 / R6		31	O	DISP
12	O	LCD_DATA_23 / R7		32	O	HSYNC
13	O	LCD_DATA_8 / G0		33	O	VSYNC
14	O	LCD_DATA_9 / G1		34	O	DE
15	O	LCD_DATA_10 / G2		35	-	*N/C*
16	O	LCD_DATA_11 / G3		36	P	GND
17	O	LCD_DATA_12 / G4		37	-	*N/C*
18	O	LCD_DATA_13 / G5		38	-	*N/C*
19	O	LCD_DATA_14 / G6		39	-	*N/C*
20	O	LCD_DATA_15 / G7		40	-	*N/C*

1.8 Touch Sensor Flex Connector J8

Connector J8 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	I/O	Y0
3	I/O	Y1
4	I/O	Y2
5	I/O	Y3
6	I/O	Y4
7	I/O	Y5
8	I/O	Y6
9	I/O	Y7
10	I/O	Y8
11	I/O	Y9
12	I/O	Y10
13	I/O	Y11
14	I/O	Y12
15	I/O	Y13
16	P	GND
17	I/O	X0
18	I/O	X1
19	I/O	X2
20	I/O	X3

Pin	Type	Description
21	I/O	X4
22	I/O	X5
23	I/O	X6
24	I/O	X7
25	I/O	X8
26	I/O	X9
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	I/O	X19
37	I/O	X20
38	I/O	X21
39	I/O	X22
40	I/O	GND or X23

2 Overview of the 4.3in PCAP Touch Module

2.1 Introduction

The 4.3in PCAP Touch Module 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 (J3 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.
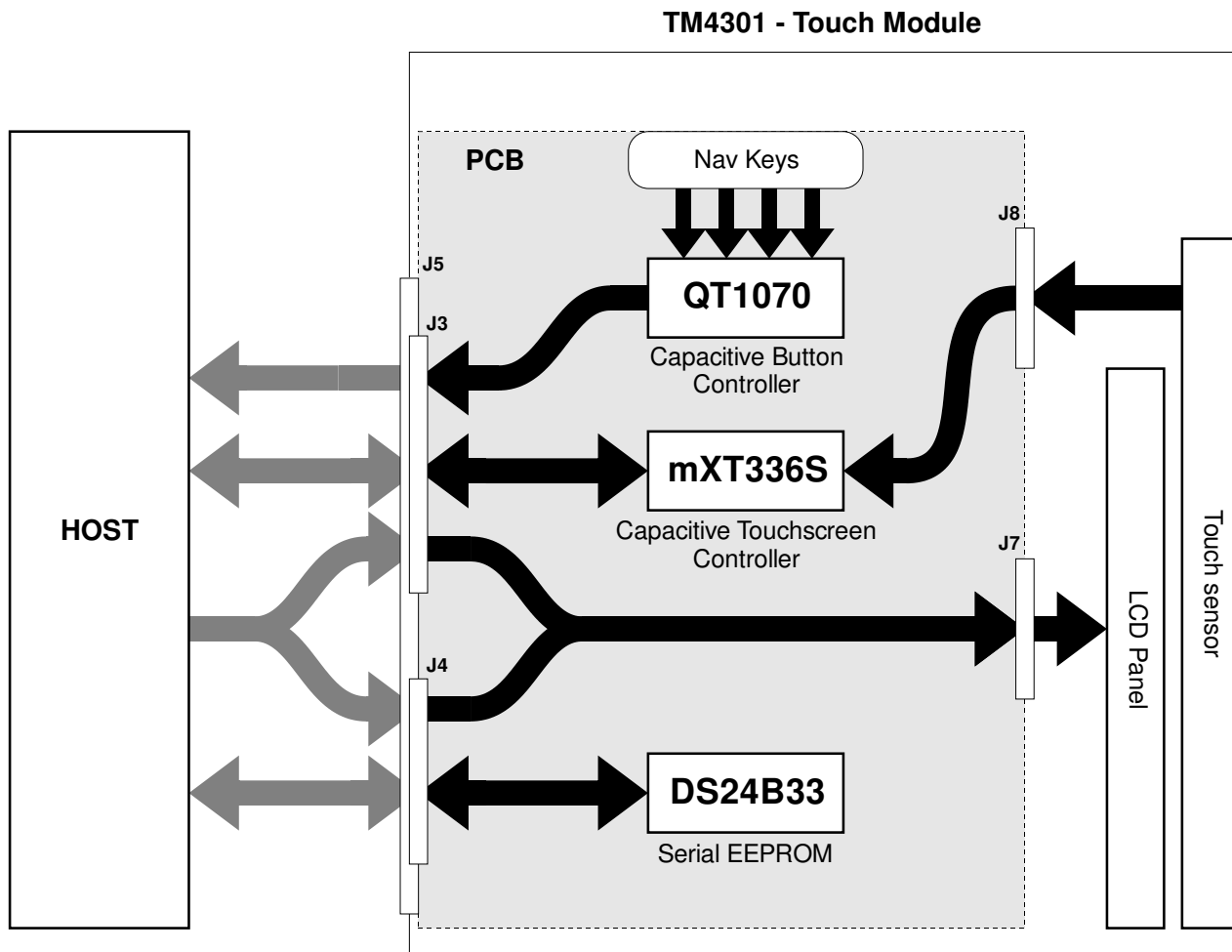
Figure 2 - Functional Block Diagram

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 I²C communication, refer to Section 5 of this document
- Atmel maXTouch mXT336S 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 J5 or Connectors J3 and J4) to the LCD panel interface (Connector J7).   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.

The LCD panel features a Himax HX8257-A internal driver IC.

2.4   maXTouch Capacitive Touchscreen Controller

The module touch screen interface is based on the Atmel maXTouch mXT336S Touch Controller and operates on the touch sensor at connector J8.

The touch controller scans the touch sensor and will signal the host with an active low interrupt signal (~MXT_CHG on J3 or J5) when new touch data is available.   Data communication with the maXTouch controller is performed over a shared I²C interface (I²C SCL and I²C SDA on J3 or J5).   The I²C address of the touch controller can be configured by populating R2 or R3 (shown below in Figure 3) according to Table 2-1 below.   The PCB ships with R3 populated – thus the I²C address is set to 0x4A by default.

NOTE: The TM4301 does not have pull-up resistors on the I²C SCL and SDA lines.   A pull-up resistor for the maXTouch ~CHG interrupt signal is located at R1.
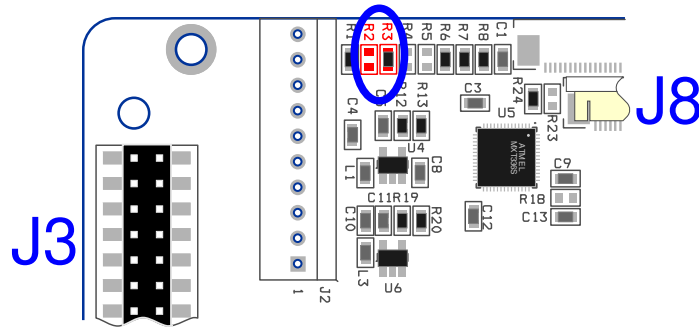
Figure 3 - Touch Controller I^{2}C Address Selection

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

R2	R3	I^{2}C Address
DNP	0 Ω	0x4A
0 Ω	DNP	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.

This 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 Sections 3.2

2.5   QTouch Capacitive Button Controller

The module's "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 (~QT_CHG on Connector J3 or J5) when a touch event has occurred.   Data communication with the QT1070 controller is performed over a shared I^{2}C interface (I^{2}C SCL and I^{2}C SDA on J3 or J5).   The I^{2}C address of the button controller is 0x1B and cannot be changed.

NOTE: The TM4301 does not have pull-up resistors on the I^{2}C SCL and SDA lines.   A pull-up resistor for the QTouch ~CHG interrupt signal is located at R22.

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 if choosing to overwrite the pre-programmed EEPROM contents. As noted above, certain builds of Linux or Android targeted for the Atmel ARM-based EKs use the EEPROM contents to identify the module and 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 (One-wire Interface on J4 or J5). Refer to the DS24B33 Datasheet (www.maximintegrated.com) for details.

3 Getting Started

This module was designed to install on a variety of Atmel ARM-based EK's including the SAM9X5-EK, SAM9N12-EK, SAMA5D3x-EK and the SAMA5D3 Xplained. This provides the fastest way to evaluate the performance of the touchscreen and display using a familiar, full-featured OS.

The following sections provide basic information related to using and evaluating the Touch Module. Visit Precision Design Associates website (www.pdaatl.com) or Atmel's AT91 Community website (www.at91.com) for more information related to this touch module or guidance appropriate for your specific EK.

3.1 Hardware Connections

The module interfaces with the EK board via one of two methods depending on the EK.   Refer to the specific EK documentation to determine which method is appropriate:

- the two large dual-row headers, J3 and J4
- the flex connector, J5

3.2 Software

Several options exist when developing for the touch module whether targeting a custom host or an Atmel EK.

3.2.1.1 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.

3.2.1.2 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.

Atmel hosts the AT91 community website with resources dedicated to developing their EKs for Android (www.at91.com/android4sam/) and Linux (www.at91.com/linux4sam/)

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

3.3 Using the Touch Module

3.3.1 Navigation Keys

When using this module with one of the standard Atmel Android demo builds, the navigation keys function as shown in Table 3-1 below:

Table 3-1 - Navigation Key Function (Android)

Key	Navigation Function
K1	↰ Back
K2	▭ Menu
K3	⌂ Home
K4	⏻ Power / Sleep

3.3.2 Evaluating 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 applications and tools depending on the host OS.

3.3.2.1   Android

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

3.3.2.2   Linux

The user can perform simple touch / drawing test using the `ts_test` utility that is part of **tslib**.

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.
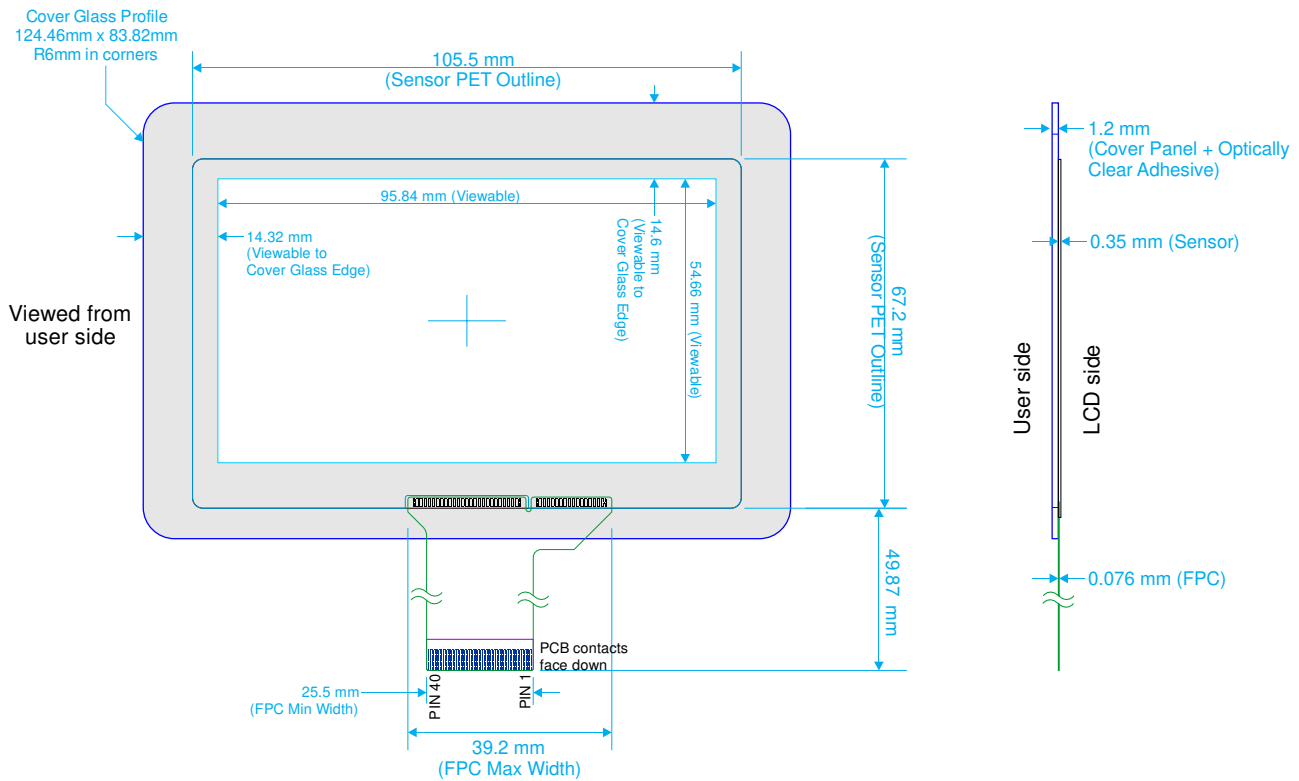
Figure 4 - Sensor Only Dimensions

Sensor (P/N: 90-00019-A1) may be purchased individually.
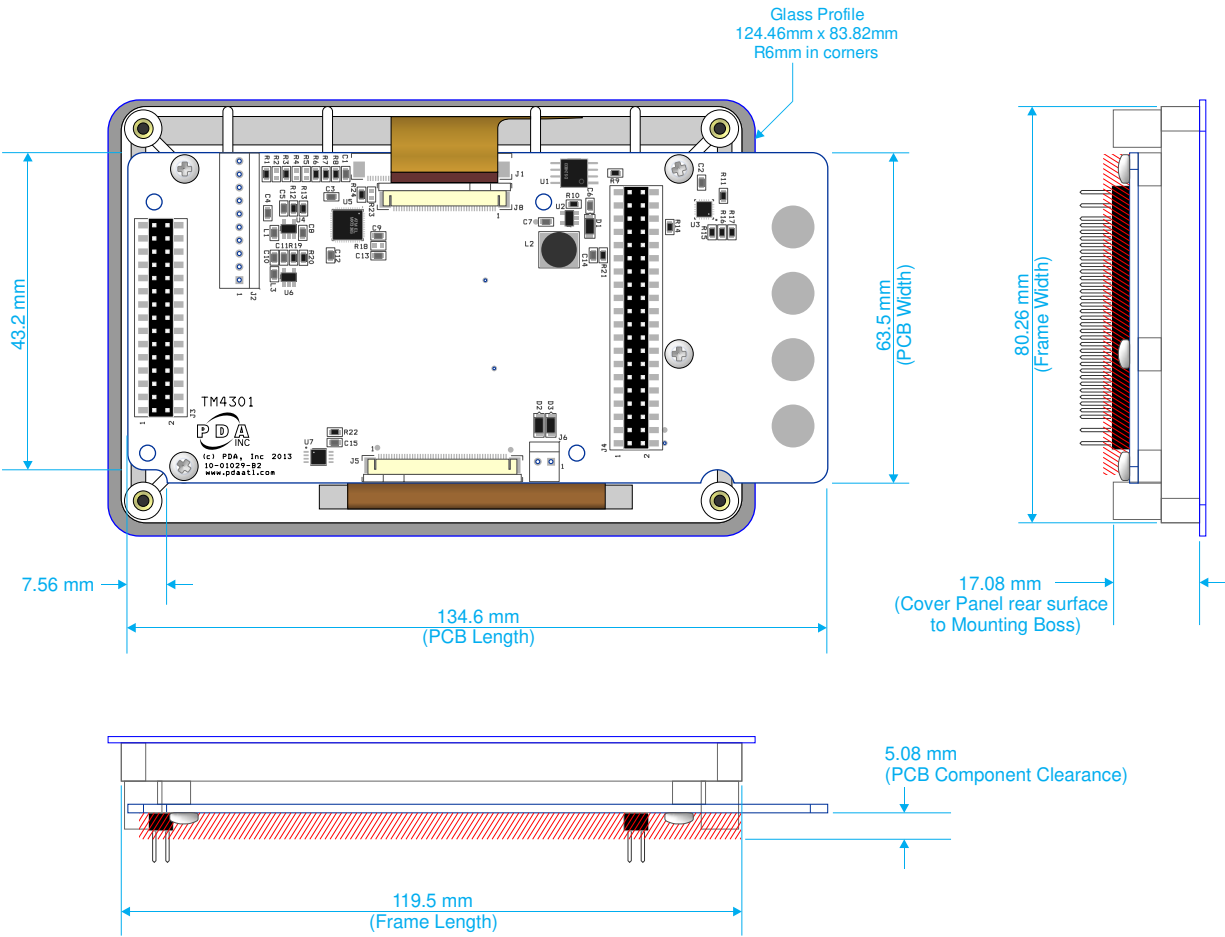Minimum order quantities apply. Contact PDA for details.

Figure 5 – Module Dimensions

4.2 Absolute Maximum Specifications

Parameter	Value
Operating temp	0^oC to $+ 70^oC$
Storage temp	-40^oC to $+ 85^oC$
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
Touchscreen Controller Address	Selectable: 0x4A or 0x4B
Navigation Key Controller Address	0x1B
Maximum bus speed (SCL)	400 kHz
I2C Specification	Version 2.1

4.6 Power Consumption

Vdd (V)	Mode	Idd (mA)
3.3Vdc	mXT336S in Free Run, LCD backlight on maximum intensity	200

4.7 Part Number

Part Number	Description
90-00002-C0	TM4301: 4.3" Touchscreen Module

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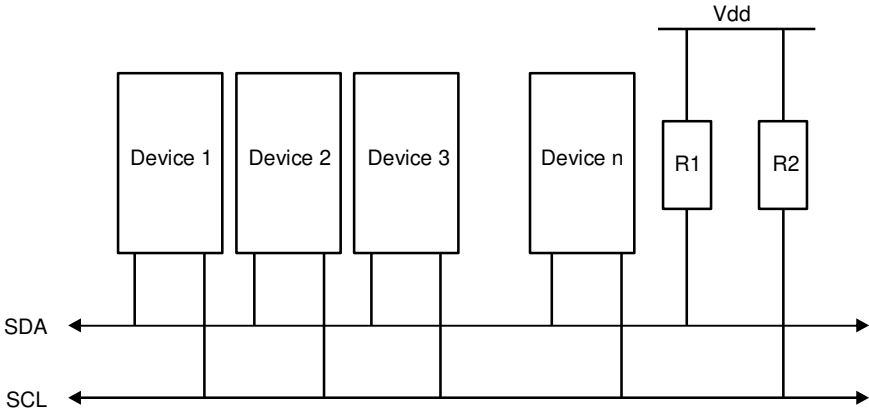
5.2   Transferring Data Bits

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 7.   Data Transfer
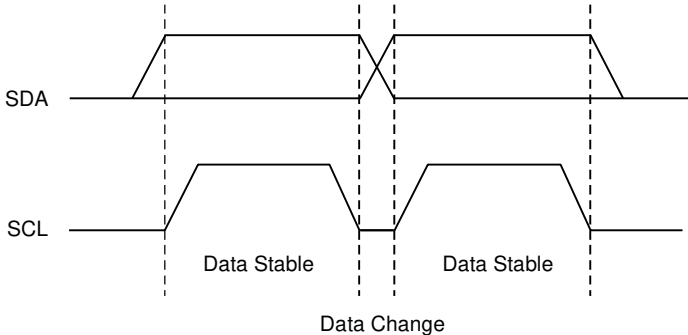
5.3   START and STOP Conditions

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 8 START and STOP conditions are signaled by changing the level of the SDA line when the SCL line is high.
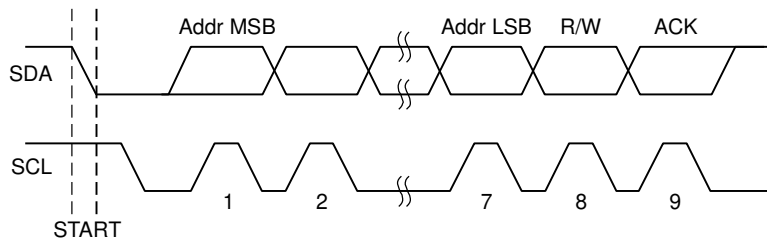
Figure 8.   START and STOP Conditions
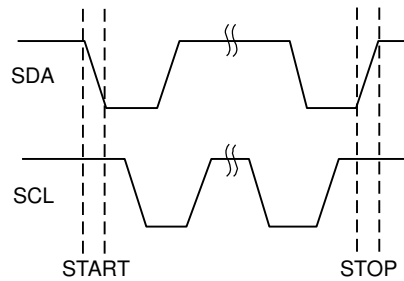
5.4 Address Byte Format

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 9.   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 10.   Data Byte Format
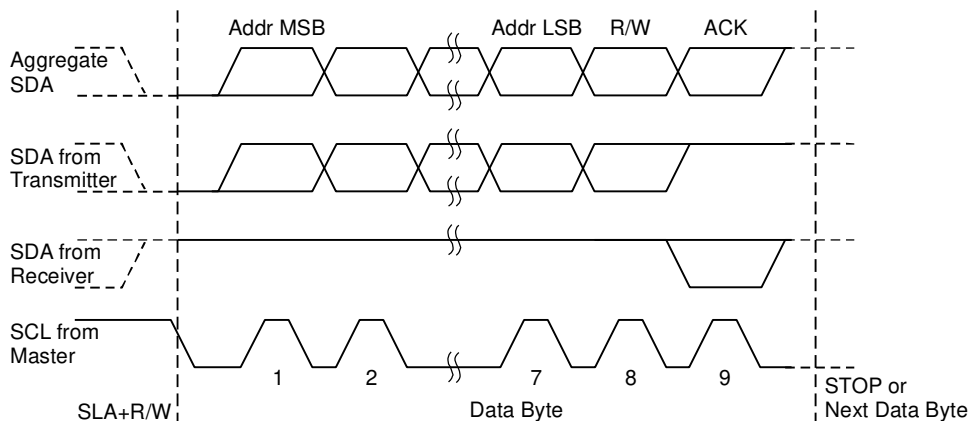
5.6 Combining Address and Data Bytes into a Transmission

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

Figure 11.   Byte Transmission
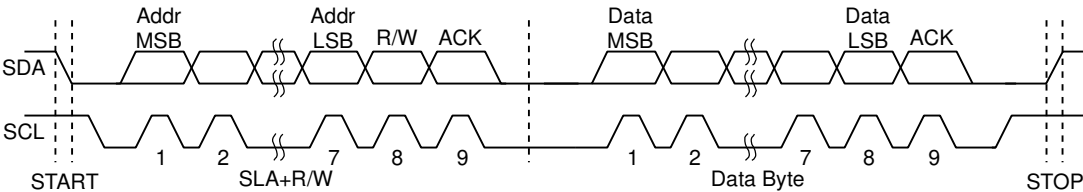
6 Revision History

Revision No.	History
Rev1403-1-1 Rev1403-1-2	Initial Draft (unreleased)
Rev1403-1-3	Preliminary Release (limited release)
Rev1404-2-4	Initial Release

7   Notes

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