maXTouch Curiosity Pro Users Guide

Preface

The maXTouch® Curiosity Pro (AC320007) is an extension board to the Curiosity MCU kit family line and Atmel Xplained Pro evaluation platform, which enables users to experiment with graphical user interface (GUI) applications with maXTouch and LCD.

The figure below illustrates the maXTouch Curiosity Pro board.



© 2020 Microchip Technology Inc.

Table of Contents

Preface....1

1. Introduction....3
   - 1.1. Features....3
   - 1.2. Kit Overview....3
   - 1.3. Additional Resources....3

2. Overview....4
   - 2.1. maXTouch® Capacitive Touchscreen Controller....4
   - 2.2. maXTouch® Controller Interface....4

3. Getting Started....5
   - 3.1. Connecting maXTouch Curiosity Pro to the Curiosity Board or Xplained Pro Board....5

4. Curiosity and Xplained Pro Boards....6
   - 4.1. Curiosity Board or Xplained Pro Headers and Connectors....6
   - 4.2. maXTouch Parallel LCD Extension Connector....6
   - 4.3. Hardware Connection at J2....7
   - 4.4. FPC or FFC Connector Pinout....7
   - 4.5. maxTouch LCD Extension Header Implementation....8
   - 4.6. Interface Selector (SW1)....9
   - 4.7. Debug Header....9

5. Specifications....11

6. Schematics....13

7. Mounting....14

8. Document Revision History....15

The Microchip Website....16

Product Change Notification Service....16

Customer Support....16

Microchip Devices Code Protection Feature....16

Legal Notice....16

Trademarks....17

Quality Management System....17

Worldwide Sales and Service....18

© 2020 Microchip Technology Inc.

1. Introduction

This section describes Microchip maXTouch Curiosity Pro features and overview of the maXTouch Curiosity Pro kit.

1.1 Features

The following are key features of the Microchip maXTouch Curiosity Pro board:

- Display
  - 3.5 inch display module
  - ILI9488 LCD driver
  - 320 x 480 resolution
  - 30 ms maximum response time
  - White back light
  - Parallel interface (up to 18 bit)
  - Parallel RGB interface
  - 3-wire and 4-wire SPI interface
- Touch
  - maXTouch capacitive touch screen controller
  - Supports up to 4 touches
- Cover panel
  - 1.1 mm soda-lime glass
- Xplained Pro hardware identification system

Kit contents

- One 3.5 inch display module
- One 50-way flexible flat cable (FFC)
- One 20-way ribbon cable (also known as multi-wire planar cable)

1.2 Kit Overview

The Microchip maXTouch Curiosity Pro is an extension board for the Xplained Pro platform with a 320 x 480 RGB LCD and a capacitive touch sensor with a maXTouch controller. The LCD can be controlled using different interfaces, such as 3-wire and 4-wire SPI, Parallel, and RGB Parallel interface mode using the DIP switch to select the interface.

The maXTouch Curiosity Pro kit can be connected to any Curiosity boards or Xplained Pro standard extension header, any curiosity Pro or Ultra kit, and many other Microchip MCUs using the 20-pin header, but is limited to 3-wire and 4-wire SPI mode.

The maXTouch Curiosity Pro also features a standard LCD connector (FFC), which enables using the parallel interfaces. Both connectors, FFC and 20-pin header, feature a SPI interface for the LCD and I^2C for the maXTouch device.

1.3 Additional Resources

For additional information, refer to these websites:

- ILI Technology Corp ILI9488 Driver IC (www.ilitek.com)
- Precision Design Associates (http://www.pdaatl.com/index.htm)

© 2020 Microchip Technology Inc.

2. Overview

2.1 maXTouch® Capacitive Touchscreen Controller

The module touch screen interface is based on the Atmel maXTouch mXT336U Touch Controller and operates on the touch sensor at connector J4. The touch controller scans the touch sensor and signals the host with an active-low interrupt signal (~MXT_CHG on J2 & J3) when a new touch data is available. Data communication with the maXTouch controller is performed over the I^2C interface (on J2 & J3). The I^2C address of the touch controller is fixed at 0 x 4A, and is not configurable.

Note: The maXTouch has pull-up resistors on the I^2C SCL (R17) and SDA (R16) lines. A pull-up resistor for the maXTouch ~CHG interrupt signal is located at R18 (10k).

2.2 maXTouch® Controller Interface

Details of the maXTouch communication protocol are beyond the scope of this document. This module is pre-loaded with a configuration already optimized for the maXTouch touch sensor and panel, hence the developer will 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 start with host interface development, users need to leverage the existing code available from MPLAB® Harmony, which is available at https://www.microchip.com/mplab/mplab-harmony.

For additional information regarding the maXTouch devices, refer to http://www.microchip.com.

© 2020 Microchip Technology Inc.

3. Getting Started

This section covers getting started with Curiosity MCUs or Xplained Pro Quick Start.

Follow these steps to exploring the Microchip Curiosity Pro platform:

1. Download and launch MPLAB® X IDE.
2. Launch the plug-in manager and install MPLAB Harmony Code Configurator.
3. Connect the maXTouch Curiosity Pro to any Microchip Curiosity platform or Xplained Pro MCU board, and connect a USB cable to the DEBUG USB port on the MCU board.

When the Curiosity MCU board or Xplained Pro MCU kit is connected to your computer for the first time, the operating system will perform a driver software installation. The driver file supports 32-bit and 64-bit versions of Microsoft® Windows® XP, Windows Vista®, Windows 7, Windows 8, and Windows 10.

After the Curiosity MCU board or Xplained Pro MCU board is powered, the green power LED will be lit and MPLAB X IDE will auto detect which Curiosity MCU board or Xplained Pro MCU and extension boards are connected. MPLAB X IDE will present relevant information, such as data sheets and kit documentation.

The target device is programmed and debugged by the on-board debugger, therefore no external programmer or debugger tool is needed.

3.1 Connecting maXTouch Curiosity Pro to the Curiosity Board or Xplained Pro Board

Microchip maXTouch Curiosity Pro is designed to connect to the Curiosity board or Xplained Pro header marked EXTx (x = 1 - 3). Refer to the pin out of the Curiosity MCU board or Xplained Pro evaluation kit to find out which Xplained Pro EXT headers can be used. The FFC connector can be used if the parallel interface from the MCU to the display is used on the kits featuring the graphical user interface. Any time only one cable must be connected.

© 2020 Microchip Technology Inc.

4. Curiosity and Xplained Pro Boards

The Curiosity boards and Xplained Pro boards are evaluation platforms that provide a full Microchip microcontroller experience to users. This platform consists of a series of microcontrollers and extension boards, which are integrated with MPLAB X IDE, MPLAB Harmony drivers, demo code, support data streaming, and so on.

The Curiosity boards or Xplained Pro boards support a wide range of Xplained Pro extension boards, which are connected through a set of standardized headers and connectors. Each extension board has an identification (ID) chip to uniquely identify which boards are connected to a Curiosity board or Xplained Pro board. This information is used to present relevant user guides, application notes, data sheets, and example code through MPLAB X IDE.

4.1 Curiosity Board or Xplained Pro Headers and Connectors

Table 4-1. Xplained Pro Standard Extension Header

Pin number	Name	Description
1	ID	Communication line to the ID chip on an extension board
2	GND	Ground
3	ADC(+)	Analog-to-digital converter, alternatively positive part of differential ADC
4	ADC(-)	Analog-to-digital converter, alternatively negative part of differential ADC
5	GPIO1	General purpose I/O
6	GPIO2	General purpose I/O
7	PWM(+)	Pulse-width modulation, alternatively positive part of differential PWM
8	PWM(-)	Pulse-width modulation, alternatively negative part of differential PWM
9	IRQ/GPIO	Interrupt request line or general purpose I/O
10	SPI_SS_B/GPIO	Slave select for SPI or general purpose I/O
11	I2C_SDA	Data line for I^2C interface. Always implemented, bus type.
12	I2C_SCL	Clock line for I^2C interface. Always implemented, bus type.
13	UART_RX	Receiver line of target device UART
14	UART_TX	Transmitter line of target device UART
15	SPI_SS_A	Slave select for SPI. Should preferably be unique.
16	SPI_MOSI	Master Out Slave In (MOSI) line of serial peripheral interface. Always implemented, bus type
17	SPI_MISO	Master In Slave Out (MISO) line of serial peripheral interface. Always implemented, bus type.
18	SPI_SCK	Clock for serial peripheral interface. Always implemented, bus type.
19	GND	Ground
20	VCC	Power for extension board

4.2 maXTouch Parallel LCD Extension Connector

The LCD connector can be connected to display extensions that have a parallel interface. The connector implements signals for an MCU parallel bus interface and a LCD controller interface, as well as signals for a touch controller. For connector pin-out definition, refer to maXTouch parallel LCD Connector.

© 2020 Microchip Technology Inc.

Note: Usually only one display interface is implemented, either the LCD controller or the MCU bus interface. A FPC or FFC connector with 50 pins and 0.5 mm pitch is used for the LCD connector.

4.3 Hardware Connection at J2

The FFC must be inserted with flex contacts facing down toward the PCB.

4.4 FPC or FFC Connector Pinout

Table 4-2. maXTouch Parallel LCD Connector

Pin Number	Name	RGB Interface Description	MCU Description
1	ID	Communication line to the ID chip on an extension board	
2	GND	Ground	
3	D0	Data Line	
4	D1	Data Line	
5	D2	Data Line	
6	D3	Data Line	
7	GND	Ground	
8	D4	Data Line	
9	D5	Data Line	
10	D6	Data Line	
11	D7	Data Line	
12	GND	Ground	
13	D8	Data Line	
14	D9	Data Line	
15	D10	Data Line	
16	D11	Data Line	
17	GND	Ground	
18	D12	Data Line	
19	D13	Data Line	
20	D14	Data Line	
21	D15	Data Line	
22	GND	Ground	
23	D16	Data Line	
24	D17	Data Line	
25	D18	Data Line	
26	D19	Data Line	
27	GND	Ground	
28	D20	Data Line	

© 2020 Microchip Technology Inc.

29	D21	Data Line	
30	D22	Data Line	
31	D23	Data Line	
32	GND	Ground	
33	PCLK/CMD DATASEL	Pixel clock	Display RAM select. One address line of the MCU for display where it is possible to select either register or data interface
34	VSYNC/CS	Vertical Synchronization	Chip select
35	HSYNC/WE	Horizontal Synchronization	Write-enable signal
36	DATA ENABLE/RE	Data-enable signal	Read-enable signal
37	SPI SCK	Clock for serial peripheral interface	
38	SPI MOSI	Master Out Slave In (MOSI) of serial peripheral interface	
39	SPI MISO	Master In Slave Out (MISO) of serial peripheral interface	
40	SPI SS	Slave select for serial peripheral interface (SPI). Preferably a dedicated pin.	
41	ENABLE	Display enable	
42	I2C_SDA	Data line for I^2C interface. Always implemented, bus type.	
43	I2C_SCL	Clock line for I^2C interface. Always implemented, bus type.	
44	IRQ1	Interrupt	
45	IRQ2	Interrupt	
46	PWM	Back light control	
47	RESET	Extension reset	
48	VCC	3.3V power supply for extension board	
49	VCC	3.3V power supply for extension board	
50	GND	Ground	

4.5 maxTouch LCD Extension Header Implementation

The following table provides the signals used by the maXTouch LCD.

Table 4-3. Signals Used by the maXTouch LCD

Pin number	Name	Description
1	ID	Communication line to the ID chip on an extension board
2	GND	Ground
3	NC	Not connected
4	NC	Not connected
5	GPIO1	General purpose I/O
6	NC	Not connected
7	PWM(+)	Pulse-width modulation, alternatively positive part of differential PWM
8	NC	Not connected

© 2020 Microchip Technology Inc.

.....continued		
Pin number	**Name**	**Description**
9	IRQ/GPIO	Interrupt request line or general purpose I/O
10	SPI_SS_B/GPIO	Slave select for SPI or general purpose I/O
11	I2C_SDA	Data line for I^2C interface. Always implemented, bus type.
12	I2C_SCL	Clock line for I^2C interface. Always implemented, bus type.
13	NC	Not connected
14	NC	Not connected
15	SPI_SS_A	Slave select for SPI. must preferably be unique.
16	SPI_MOSI	Master Out Slave In (MOSI) line of serial peripheral interface. Always implemented, bus type
17	SPI_MISO	Master In Slave Out line (MISO) of serial peripheral interface. Always implemented, bus type.
18	SPI_SCK	Clock for serial peripheral interface. Always implemented, bus type.
19	GND	Ground
20	VCC	Power for extension board

4.6 Interface Selector (SW1)

The maXTouch Pro LCD has a series of selector switches to control the mode the ILI9844 controller operates in. These switches can be found on the back of the LCD. The table below details how the switches change the mode. and the switch settings have to match the software that is loaded on the host microcontroller.

IM2	IM1	IM0	Interface	Pins in use
0	0	0	18-bit parallel bus	DB[17:0], CS, D/C, WE, RE
0	0	1	9-bit parallel bus	DB[8:0], CS, D/C, WE, RE
0	1	0	16-bit parallel bus	DB[15:0], CS, D/C, WE, RE
0	1	1	8-bit parallel bus	DB[7:0], CS, D/C, WE, RE
1	0	0	Not Supported	
1	0	1	3-wire/9-bit SPI mode	MOSI, MISO, SCLK, CS,
1	1	0	Not Supported	
1	1	1	4-wire/8-bit SPI mode	MOSI, MISO, SCLK, CS, D/C

4.7 Debug Header

Extra debug connections of the maXTouch controller is provided for easy access.

Pin Number	Pin Name	Pin Description
1	NC	No connect
2	NC	No connect
3	IRQ	Interrupt (maXTouch) Active-Low
4	Reset	Reset (maxTouch) Active-Low

© 2020 Microchip Technology Inc.

.....continued

Pin Number	Pin Name	Pin Description
5	I2C_SDA	Data line for I^2C interface. Always implemented, bus type.
6	I2C_SCL	Clock line for I^2C interface. Always implemented, bus type.
7	VCC	3.3V power supply for extension board
8	GND	Ground
9	Debug Data	Debug output
10	Debug Clock	Debug clock

© 2020 Microchip Technology Inc.

5. Specifications

Table 5-1. Module Parameters

Parameter	Value
Module size	3.5 inch
Overall dimensions	69.96 mm (H) x 94.44 mm (W) x 8.7 mm (T)
Overall weight	48.8 gm

Table 5-2. Absolute Maximum Specifications

Parameter	Value
Operating temp	0ºC to +70ºC
Storage temp	-30ºC to +80ºC
VDD	-0.5 to +6V
VDDIO	-0.5 to +3.6V
Maximum 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 in the above table may cause permanent damage to the device. This is a stress rating only and the 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.

Table 5-3. Recommended Operating Conditions

Parameter	Value
VIN	3.3V
Supply ripple + noise	±20 mV

Table 5-4. DC Specifications

Parameter	Description	Min.	Typ	Max.	Units	Notes
VIL	Low-input logic level	-0.5	-	0.3 VDD	V	1.8V <VDD <3.3V
VHL	High- input logic level	0.7 VDD	-		V	1.8V <VDD <3.3V
VOL	Low- output voltage		-	0.2 VDD	V	
VOH	High- output voltage	0.8 VDD	-	-	V	
IIL	Input leakage current		-	1	µA	
VIN = 3.3V, VDD = 2.8 VDC, TA = recommended range, unless otherwise noted.						

Table 5-5. I^2C Compatible Bus Specifications

Parameter	Operation
Touchscreen controller address	0x4A

© 2020 Microchip Technology Inc.

.....continued	
Parameter	**Operation**
Maximum bus speed (SCL)	1 MHz
I^2C specification	Version 2.1
Bus voltage	3.3V

Table 5-6. LCD Module Specifications

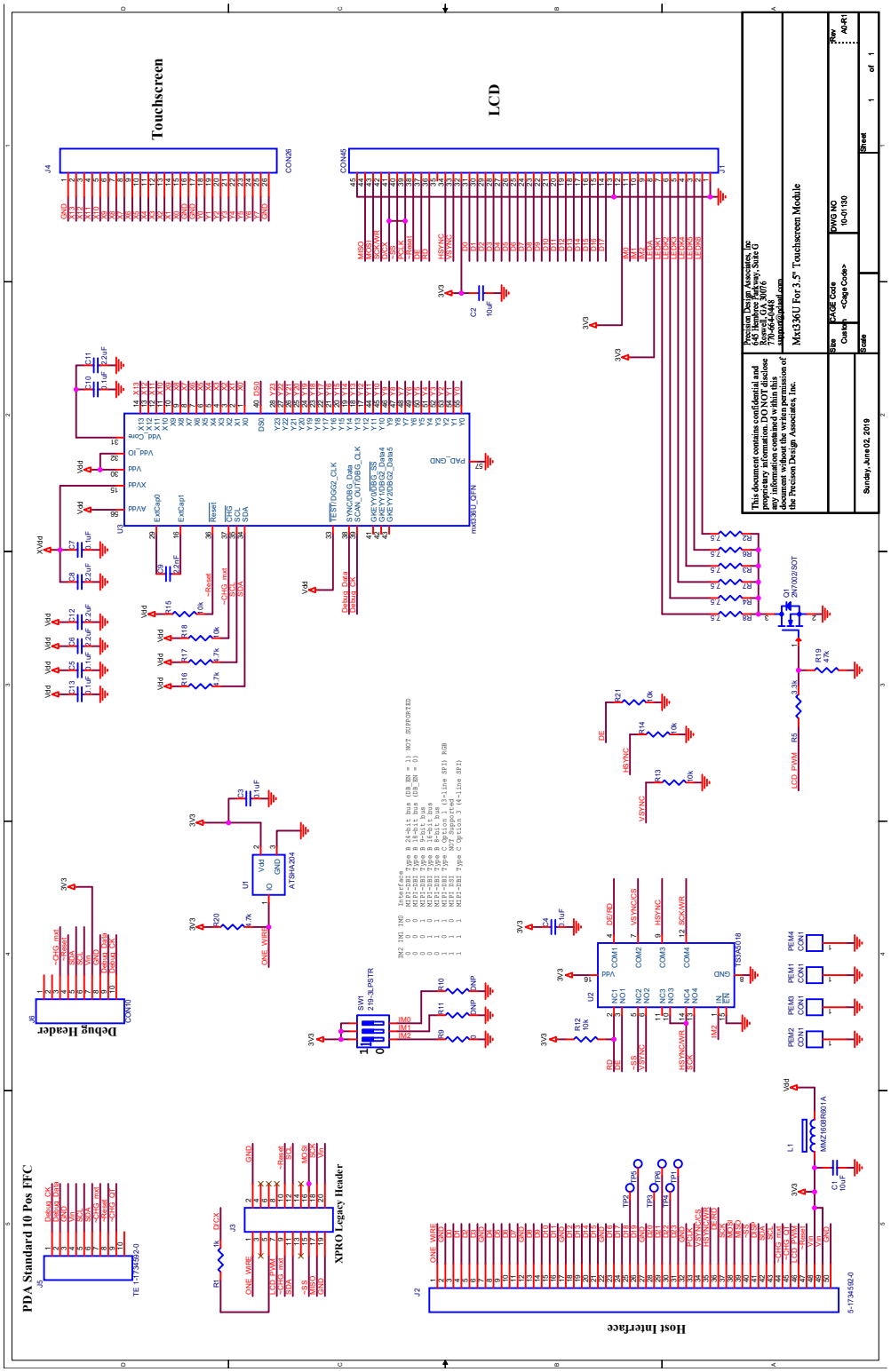
Parameter	Value
Display size	3.5 inch
LCD type	-Si TFT
Display mode	TN/Transmissive
Resolution	320 x RGB x 480
View direction (Best Image)	6 O'clock (Portrait, LCD flex end at bottom)
Dimensions	54.16 mm (H) x 84.21 mm (W) x 2.15 mm (T)
Active area	48.96 mm x 73.44 mm
Pixel size	0.153 mm x 0.153 mm
Pixel arrangement	Stripe
Display colors	262K

Table 5-7. Backlight Specifications

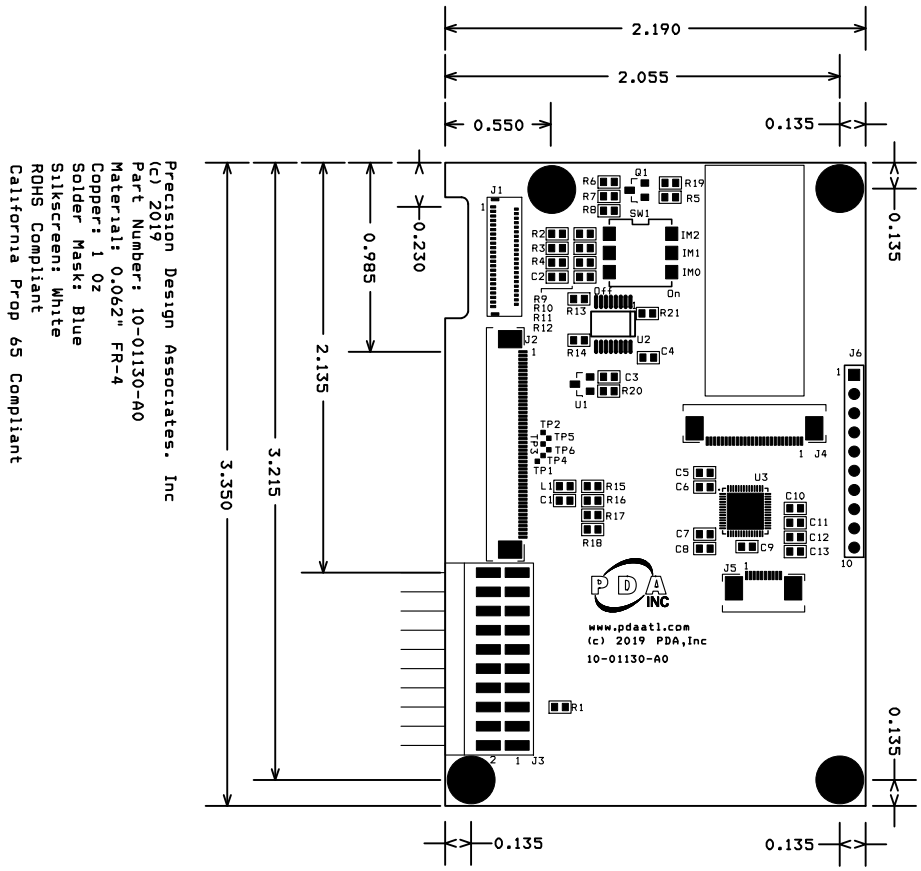
Parameter	Description	Min.	Typ.	Max.	Units
VF	Forward Voltage (TA = 25 ºC, IF = 15 mA)	-	3.2	3.5	V
IF	Forward Current (TA = 25ºC, VF = 3.2A), per LED	-	20	-	mA
	LED Configuration	6x White LED in parallel			
LV	Luminance	280	300	-	Cd/m2
Avg	Uniformity	80	85	-	%
Pd	Power Dissipation	-	384	-	mW
Vak	Backlight Driving Voltage	-	3.3	3.5	V

© 2020 Microchip Technology Inc.

6. Schematics



7. Mounting


Precision Design Associates, Inc
(c) 2019
Part Number: 10-01130-A0
Material: 0.062" FR-4
Copper: 1 Oz
Solder Mask: Blue
Silkscreen: White
ROHS Compliant
California Prop 65 Compliant
2.190
2.055
0.550
0.135
0.135
0.230
0.985
2.135
3.350
3.215
0.135
0.135
0.135
J1
J2
J3
J4
J5
J6
U1
U2
U3
Q1
SW1
TP1
TP2
TP4
TP5
TP6
IM2
IM1
IM0
www.pdaatl.com
(c) 2019 PDA,Inc
10-01130-A0

8. Document Revision History

Revision B - 03/2020

Updated the Features section with the following information:

- Removed erroneous information regarding a projected capacitive multi-touch controller
- Updated the size of the display module in Kit Contents to 3.5 inches

Revision A - 01/2020

This is the initial released version of this document.

The Microchip Website

Microchip provides online support via our website at http://www.microchip.com/. This website is used to make files and information easily available to customers. Some of the content available includes:

- **Product Support** – Data sheets and errata, application notes and sample programs, design resources, user's guides and hardware support documents, latest software releases and archived software
- **General Technical Support** – Frequently Asked Questions (FAQs), technical support requests, online discussion groups, Microchip design partner program member listing
- **Business of Microchip** – Product selector and ordering guides, latest Microchip press releases, listing of seminars and events, listings of Microchip sales offices, distributors and factory representatives

Product Change Notification Service

Microchip's product change notification service helps keep customers current on Microchip products. Subscribers will receive email notification whenever there are changes, updates, revisions or errata related to a specified product family or development tool of interest.

To register, go to http://www.microchip.com/pcn and follow the registration instructions.

Customer Support

Users of Microchip products can receive assistance through several channels:

- Distributor or Representative
- Local Sales Office
- Embedded Solutions Engineer (ESE)
- Technical Support

Customers should contact their distributor, representative or ESE for support. Local sales offices are also available to help customers. A listing of sales offices and locations is included in this document.

Technical support is available through the website at: http://www.microchip.com/support

Microchip Devices Code Protection Feature

Note the following details of the code protection feature on Microchip devices:

- Microchip products meet the specification contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.
- There are dishonest and possibly illegal methods used to breach the code protection feature. All of these methods, to our knowledge, require using the Microchip products in a manner outside the operating specifications contained in Microchip's Data Sheets. Most likely, the person doing so is engaged in theft of intellectual property.
- Microchip is willing to work with the customer who is concerned about the integrity of their code.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not mean that we are guaranteeing the product as "unbreakable."

Code protection is constantly evolving. We at Microchip are committed to continuously improving the code protection features of our products. Attempts to break Microchip's code protection feature may be a violation of the Digital Millennium Copyright Act. If such acts allow unauthorized access to your software or other copyrighted work, you may have a right to sue for relief under that Act.

Legal Notice

Information contained in this publication regarding device applications and the like is provided only for your convenience and may be superseded by updates. It is your responsibility to ensure that your application meets with

your specifications. MICROCHIP MAKES NO REPRESENTATIONS OR WARRANTIES OF ANY KIND WHETHER EXPRESS OR IMPLIED, WRITTEN OR ORAL, STATUTORY OR OTHERWISE, RELATED TO THE INFORMATION, INCLUDING BUT NOT LIMITED TO ITS CONDITION, QUALITY, PERFORMANCE, MERCHANTABILITY OR FITNESS FOR PURPOSE. Microchip disclaims all liability arising from this information and its use. Use of Microchip devices in life support and/or safety applications is entirely at the buyer's risk, and the buyer agrees to defend, indemnify and hold harmless Microchip from any and all damages, claims, suits, or expenses resulting from such use. No licenses are conveyed, implicitly or otherwise, under any Microchip intellectual property rights unless otherwise stated.

Trademarks

The Microchip name and logo, the Microchip logo, Adaptec, AnyRate, AVR, AVR logo, AVR Freaks, BesTime, BitCloud, chipKIT, chipKIT logo, CryptoMemory, CryptoRF, dsPIC, FlashFlex, flexPWR, HELDO, IGLOO, JukeBlox, KeeLoq, Kleer, LANCheck, LinkMD, maXStylus, maXTouch, MediaLB, megaAVR, Microsemi, Microsemi logo, MOST, MOST logo, MPLAB, OptoLyzer, PackeTime, PIC, picoPower, PICSTART, PIC32 logo, PolarFire, Prochip Designer, QTouch, SAM-BA, SenGenuity, SpyNIC, SST, SST Logo, SuperFlash, Symmetricom, SyncServer, Tachyon, TempTrackr, TimeSource, tinyAVR, UNI/O, Vectron, and XMEGA are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

APT, ClockWorks, The Embedded Control Solutions Company, EtherSynch, FlashTec, Hyper Speed Control, HyperLight Load, IntelliMOS, Libero, motorBench, mTouch, Powermite 3, Precision Edge, ProASIC, ProASIC Plus, ProASIC Plus logo, Quiet-Wire, SmartFusion, SyncWorld, Temux, TimeCesium, TimeHub, TimePictra, TimeProvider, Vite, WinPath, and ZL are registered trademarks of Microchip Technology Incorporated in the U.S.A.

Adjacent Key Suppression, AKS, Analog-for-the-Digital Age, Any Capacitor, AnyIn, AnyOut, BlueSky, BodyCom, CodeGuard, CryptoAuthentication, CryptoAutomotive, CryptoCompanion, CryptoController, dsPICDEM, dsPICDEM.net, Dynamic Average Matching, DAM, ECAN, EtherGREEN, In-Circuit Serial Programming, ICSP, INICnet, Inter-Chip Connectivity, JitterBlocker, KleerNet, KleerNet logo, memBrain, Mindi, MiWi, MPASM, MPF, MPLAB Certified logo, MPLIB, MPLINK, MultiTRAK, NetDetach, Omniscient Code Generation, PICDEM, PICDEM.net, PICkit, PICtail, PowerSmart, PureSilicon, QMatrix, REAL ICE, Ripple Blocker, SAM-ICE, Serial Quad I/O, SMART-I.S., SQI, SuperSwitcher, SuperSwitcher II, Total Endurance, TSHARC, USBCheck, VariSense, ViewSpan, WiperLock, Wireless DNA, and ZENA are trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

SQTP is a service mark of Microchip Technology Incorporated in the U.S.A.

The Adaptec logo, Frequency on Demand, Silicon Storage Technology, and Symmcom are registered trademarks of Microchip Technology Inc. in other countries.

GestIC is a registered trademark of Microchip Technology Germany II GmbH & Co. KG, a subsidiary of Microchip Technology Inc., in other countries.

All other trademarks mentioned herein are property of their respective companies.

© 2019, Microchip Technology Incorporated, Printed in the U.S.A., All Rights Reserved.

ISBN: 978-1-5224-5730-5

Quality Management System

For information regarding Microchip's Quality Management Systems, please visit http://www.microchip.com/quality.

Worldwide Sales and Service

AMERICAS	ASIA/PACIFIC	ASIA/PACIFIC	EUROPE
Corporate Office 2355 West Chandler Blvd. Chandler, AZ 85224-6199 Tel: 480-792-7200 Fax: 480-792-7277 Technical Support: http://www.microchip.com/support Web Address: http://www.microchip.com **Atlanta** Duluth, GA Tel: 678-957-9614 Fax: 678-957-1455 **Austin, TX** Tel: 512-257-3370 **Boston** Westborough, MA Tel: 774-760-0087 Fax: 774-760-0088 **Chicago** Itasca, IL Tel: 630-285-0071 Fax: 630-285-0075 **Dallas** Addison, TX Tel: 972-818-7423 Fax: 972-818-2924 **Detroit** Novi, MI Tel: 248-848-4000 **Houston, TX** Tel: 281-894-5983 **Indianapolis** Noblesville, IN Tel: 317-773-8323 Fax: 317-773-5453 Tel: 317-536-2380 **Los Angeles** Mission Viejo, CA Tel: 949-462-9523 Fax: 949-462-9608 Tel: 951-273-7800 **Raleigh, NC** Tel: 919-844-7510 **New York, NY** Tel: 631-435-6000 **San Jose, CA** Tel: 408-735-9110 Tel: 408-436-4270 **Canada - Toronto** Tel: 905-695-1980 Fax: 905-695-2078	**Australia - Sydney** Tel: 61-2-9868-6733 **China - Beijing** Tel: 86-10-8569-7000 **China - Chengdu** Tel: 86-28-8665-5511 **China - Chongqing** Tel: 86-23-8980-9588 **China - Dongguan** Tel: 86-769-8702-9880 **China - Guangzhou** Tel: 86-20-8755-8029 **China - Hangzhou** Tel: 86-571-8792-8115 **China - Hong Kong SAR** Tel: 852-2943-5100 **China - Nanjing** Tel: 86-25-8473-2460 **China - Qingdao** Tel: 86-532-8502-7355 **China - Shanghai** Tel: 86-21-3326-8000 **China - Shenyang** Tel: 86-24-2334-2829 **China - Shenzhen** Tel: 86-755-8864-2200 **China - Suzhou** Tel: 86-186-6233-1526 **China - Wuhan** Tel: 86-27-5980-5300 **China - Xian** Tel: 86-29-8833-7252 **China - Xiamen** Tel: 86-592-2388138 **China - Zhuhai** Tel: 86-756-3210040	**India - Bangalore** Tel: 91-80-3090-4444 **India - New Delhi** Tel: 91-11-4160-8631 **India - Pune** Tel: 91-20-4121-0141 **Japan - Osaka** Tel: 81-6-6152-7160 **Japan - Tokyo** Tel: 81-3-6880- 3770 **Korea - Daegu** Tel: 82-53-744-4301 **Korea - Seoul** Tel: 82-2-554-7200 **Malaysia - Kuala Lumpur** Tel: 60-3-7651-7906 **Malaysia - Penang** Tel: 60-4-227-8870 **Philippines - Manila** Tel: 63-2-634-9065 **Singapore** Tel: 65-6334-8870 **Taiwan - Hsin Chu** Tel: 886-3-577-8366 **Taiwan - Kaohsiung** Tel: 886-7-213-7830 **Taiwan - Taipei** Tel: 886-2-2508-8600 **Thailand - Bangkok** Tel: 66-2-694-1351 **Vietnam - Ho Chi Minh** Tel: 84-28-5448-2100	**Austria - Wels** Tel: 43-7242-2244-39 Fax: 43-7242-2244-393 **Denmark - Copenhagen** Tel: 45-4450-2828 Fax: 45-4485-2829 **Finland - Espoo** Tel: 358-9-4520-820 **France - Paris** Tel: 33-1-69-53-63-20 Fax: 33-1-69-30-90-79 **Germany - Garching** Tel: 49-8931-9700 **Germany - Haan** Tel: 49-2129-3766400 **Germany - Heilbronn** Tel: 49-7131-72400 **Germany - Karlsruhe** Tel: 49-721-625370 **Germany - Munich** Tel: 49-89-627-144-0 Fax: 49-89-627-144-44 **Germany - Rosenheim** Tel: 49-8031-354-560 **Israel - Ra'anana** Tel: 972-9-744-7705 **Italy - Milan** Tel: 39-0331-742611 Fax: 39-0331-466781 **Italy - Padova** Tel: 39-049-7625286 **Netherlands - Drunen** Tel: 31-416-690399 Fax: 31-416-690340 **Norway - Trondheim** Tel: 47-72884388 **Poland - Warsaw** Tel: 48-22-3325737 **Romania - Bucharest** Tel: 40-21-407-87-50 **Spain - Madrid** Tel: 34-91-708-08-90 Fax: 34-91-708-08-91 **Sweden - Gothenberg** Tel: 46-31-704-60-40 **Sweden - Stockholm** Tel: 46-8-5090-4654 **UK - Wokingham** Tel: 44-118-921-5800 Fax: 44-118-921-5820

© 2020 Microchip Technology Inc.