MICROCHIP

T10

T10 Xplained Pro User's Guide

Preface

> **Important:** **Notice to customers:**
>
> All documentation becomes dated, and this manual is no exception. Microchip tools and documentation are constantly evolving to meet customer needs, so some actual dialogs and/or tool descriptions may differ from those in this document. Please refer to our website (www.microchip.com) to obtain the latest documentation available.
>
> Documents are identified with a "DS" number. This number is located on the bottom of each page, in front of the page number. The numbering convention for the DS number is "DSXXXXXA", where "XXXXX" is the document number and "A" is the revision level of the document.
>
> For the most up-to-date information on development tools, see the MPLAB® IDE online help. Select the Help menu, and then Topics to open a list of available online help files.

Introduction

The Microchip T10 Xplained Pro is an extension board that evaluates mutual capacitive touch sensing. It supports Boosted Touch - a solution developed by Microchip Technology to double the signal-to-noise ratio (SNR) in mutual designs or to reduce the acquisition time by a factor of 4.

The Xplained Pro Connector ensures that the T10 can be used with many MCU XPRO boards as well as Curiosity Nano MCU Boards. Microchip MCUs feature dedicated Touch core independent peripheral (CIP) to offload the core while touch sensing. The board shows how easy it is to design capacitive touch solution for the dedicated CIPs without the need of external components. The kit includes one board with a mutual capacitance slider, and four mutual capacitance buttons. It also has 12 LEDs to indicate the button status and the slider position.
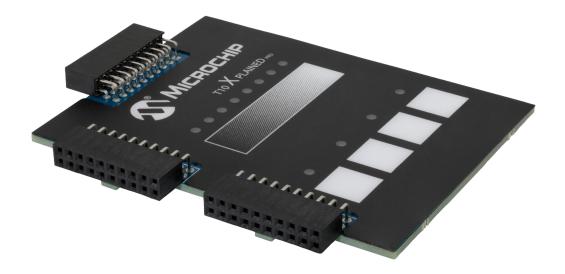
Table of Contents

1. Introduction

1.1 Features and Overview

- Four Mutual Capacitance Keypads (Buttons)
- One Mutual Capacitance Slider
- 12 LEDs:
  - One LED for each key
  - Eight LEDs for the slider position
- LED Driver: MCP23017
- Xplained Pro Hardware Identification System

1.2 Kit Compatibility

This kit is supported by Xplained Pro Microcontroller (MCU) boards that have a capacitive touch enabled MCU and a matching pinout that connects all extension sensors.
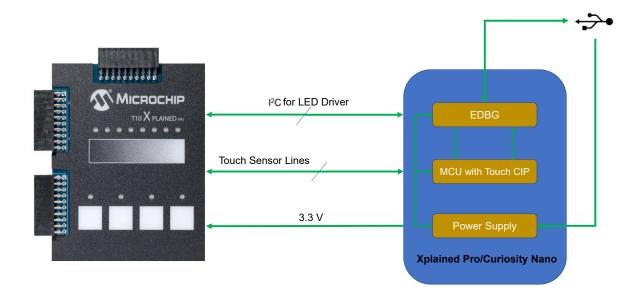
Currently supported MCU boards are:

- ATtiny817 Xplained Pro
- ATtiny3217 Xplained Pro
- ATmega324PB Xplained Pro
- SAM D11 Xplained Pro
- SAM D20 Xplained Pro
- SAM D21 Xplained Pro
- SAM DA1 Xplained Pro
- SAM C21 Xplained Pro
- SAM L10 Xplained Pro
- SAM L11 Xplained Pro
- SAM L21 Xplained Pro
- SAM L22 Xplained Pro
- SAM E54 Xplained Pro

By using either the Curiosity Nano Touch Adapter or the Curiosity Nano Adapter Board, the T10 with Curiosity Nano MCU boards may also be used. Such boards are:
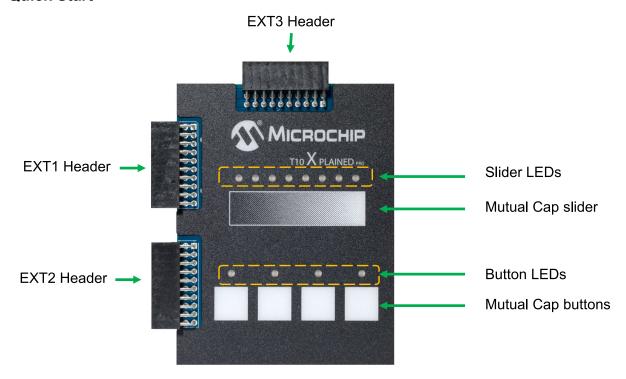
- AVR-128DA48 Curiosity Nano
- PIC16F18446 Curiosity Nano
- ATMega4809 Curiosity Nano
- SAMD21 Curiosity Nano
- ATTiny3217 Curiosity Nano

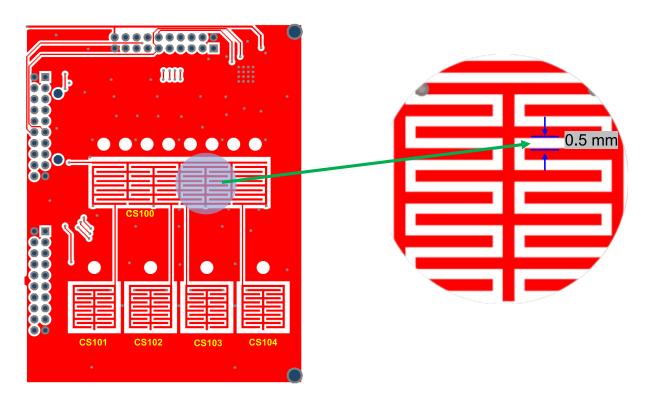## 1.3   T10 Xplained Pro Functional Block Diagram

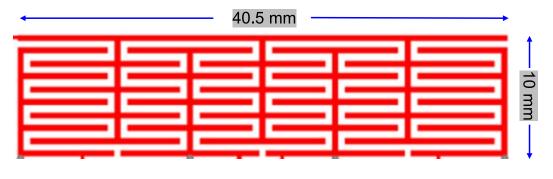# 2. Getting Started

2.1 Quick Start

2.2 Sensor Design

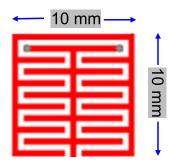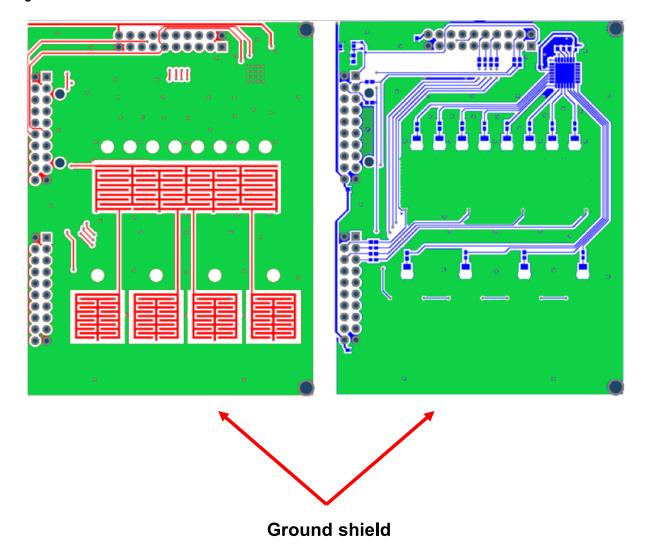**Figure 2-1. Mutual Cap Sensor**

Figure 2-2. Ground Shield

Ground shield

2.3 Documentation and Relevant Links

- **Xplained products**: The Xplained Evaluation Kits are a series of easy-to-use evaluation kits for Microchip microcontrollers and other Microchip products.
  - Xplained Nano - used for low pin count devices, and provides a minimalistic solution with access to all I/O pins of the target microcontroller.
  - Xplained Mini - used for medium pin count devices, and adds an Arduino Uno compatible header footprint and a prototyping area.
  - Xplained Pro - used for medium-to-high pin count devices that feature advanced debugging and standardized extensions for peripheral functions.
- **Curiosity products**: Curiosity is a cost-effective, fully integrated 8-bit development platform targeted at first time users, Makers, and is a feature-rich rapid prototyping board. Designed from the ground up to take full advantage of Microchip's MPLAB® X development environment, Curiosity includes an integrated programmer/debugger, and requires no additional hardware.
  Note: All the above kits have on-board programmers/debuggers, which create a set of low-cost boards for evaluation and demonstration of the features and capabilities of different Microchip products.
- **Microchip Touch**: Find the complete touch offering from Microchip:

- 1D - Buttons, sliders and wheels
- 2D - Touchscreens and touchpads
- 3D - Gesture recognition
- **Microchip Developer**: Find the complete technical touch reference:
  - Step by step guides
  - Design guides
  - Tutorial videos

  All Microchip Touch things in one place.
- **Touch design guide**: Complete touch hardware design guide for Microchip Touch solutions.

Software/IDE

- **MPLAB® X IDE**: MPLAB X IDE is a software program that runs on a PC (Windows®, Mac OS®, Linux®) to develop applications for Microchip microcontrollers and digital signal controllers. It is called an Integrated Development Environment (IDE) because it provides a single integrated "environment" to develop code for embedded microcontrollers.
- **MPLAB® Code Configurator**: MPLAB Code Configurator (MCC) is a free, graphical programming environment that generates seamless, easy-to-understand C code to be inserted into the project. Using an intuitive interface, it enables and configures a rich set of peripherals and functions specific to the application.
- **MPLAB® Harmony v3**: MPLAB Harmony v3 is a fully integrated embedded software development framework, providing flexible and interoperable software modules that allow using the resources to create applications for the 32-bit PIC® and SAM devices, rather than dealing with device details, complex protocols and library integration challenges. It works seamlessly with MPLAB X IDE and the MPLAB XC32 Compiler to enable a smooth transition and maximum code reuse between PIC32 MCUs and SAM MCUs and MPUs.
- **Atmel Start**: Atmel START is an online tool that helps the user to select and configure software components, and tailor the embedded application in a usable and optimized manner.
- **Atmel Studio**: Free IDE for the development of C/C++ and assembler code for microcontrollers.
- **Data Visualizer**: Data Visualizer is a program used for processing and visualizing data. The Data Visualizer can receive data from various sources such as the EDBG Data Gateway Interface found on Curiosity Nano and Xplained Pro boards and COM ports.
- **Design documentation**: Package containing CAD source, schematics, BOM, assembly drawings, 3D plots, layer plots, etc.
- **Hardware user's guide**: PDF version of this user's guide.
- **T10 Xplained Pro**: On Microchip's website.

Turnkey Touch Devkits

- CAP1188 Evaluation Kit: http://www.microchip.com/DevelopmentTools/ProductDetails/PartNo/dm160222
- CAP1298 Evaluation Kit: http://www.microchip.com/DevelopmentTools/ProductDetails/PartNo/dm160223
- MTCH108 Evaluation Board: http://www.microchip.com/DevelopmentTools/ProductDetails/PartNo/dm160229
- AT42QT1010 Evaluation Kit: https://www.microchip.com/developmenttools/ProductDetails/AC160219

3.   Xplained Pro

The Xplained Pro is an evaluation platform that contains a series of microcontroller boards (evaluation kits) and extension boards. Atmel Studio/MPLAB is used to program and debug the microcontrollers on these boards. Atmel Studio includes an Advanced Software Framework (ASF) and Atmel START/MPLAB Harmony v3, which has drivers, demo code, and Data Visualizer that supports data streaming and advanced debugging.

The Xplained Pro Evaluation Kits can be connected to a wide range of Xplained Pro Extension Boards through standardized headers and connectors.

Curiosity Nano
Curiosity Nano is an evaluation platform that provides a set of small boards with access to most of the microcontroller's I/Os. The platform consists of a series of low pin count MCU boards, which are integrated with Atmel Studio/Microchip MPLAB X to present relevant user guides, application notes, data sheets, and example code. The platform features a Virtual COM port (CDC) for serial communication to a host PC and a Data Gateway Interface (DGI) GPIO.

3.1   Hardware Identification System

All Xplained Pro extension boards come with an identification CryptoAuthentication™ chip (ATSHA204A) to uniquely identify the boards that are connected to the Xplained Pro Evaluation kit. This chip contains information that identifies the extension with its name, and some extra data. When an Xplained Pro extension is connected to an Xplained Pro Evaluation Kit, the information is read and sent to Atmel Studio. The following table shows the data fields stored in the ID chip with example content.

Table 3-1. Xplained Pro ID Chip Content

Data Field	Data Type	Example Content
Manufacturer	ASCII string	Microchip'\0'
Product name	ASCII string	Segment T10 Xplained Pro'\0'
Product revision	ASCII string	01'\0'
Product serial number	ASCII string	3338011800000001'\0'
Minimum voltage [mV]	uint16_t	3000
Maximum voltage [mV]	uint16_t	3600
Maximum current [mA]	uint16_t	30

3.2   Xplained Pro Standard Connectors

3.2.1   Xplained Pro Standard Extension Headers

All Xplained Pro kits have many dual row, 20-pin, 100-mil extension headers. The Xplained Pro MCU boards have male headers, while the Xplained Pro extensions have female counterparts. The following table provides the pin description of all the connected pins.

Table 3-2. Xplained Pro Standard Extension Header

Pin Number	Pin Name	Description
1	ID	Pin to communicate with the ID chip on an extension board
2	GND	Ground

Pin Number	Pin Name	Description
3	ADC(+)	Analog-to-Digital Converter; alternatively, a pin for the positive terminal of a differential ADC
4	ADC(-)	Analog-to-Digital Converter; alternatively, a pin for the negative terminal of a differential ADC
5	GPIO1	General purpose I/O pin
6	GPIO2	General purpose I/O pin
7	PWM(+)	Pulse-Width Modulation; alternatively, a pin for the positive part of a differential PWM
8	PWM(-)	Pulse-Width Modulation; alternatively, a pin for the negative part of a differential PWM
9	IRQ/GPIO	Interrupt request pin and/or general purpose I/O pin
10	SPI_SS_B/ GPIO	Slave select pin for Serial Peripheral Interface (SPI) and/or general purpose I/O pin
11	I2C _SDA	Data pin for I^2C interface. Always connected, bus type
12	I2C _SCL	Clock pin for I^2C interface. Always connected, bus type
13	UART_RX	Receiver pin of target device UART
14	UART_TX	Transmitter pin of target device UART
15	SPI_SS_A	Slave select for SPI. This pin is not connected to anything else
16	SPI_MOSI	SPI master out, slave in pin. Always connected, bus type
17	SPI_MISO	SPI master in, slave out pin. Always connected, bus type
18	SPI_SCK	SPI clock pin. Always connected, bus type
19	GND	Ground pin for extension boards
20	VCC	Power pin for extension boards

Note: Not all pins are always connected on all extension headers.

The extension headers can be used to connect a variety of Xplained Pro extensions to Xplained Pro MCU boards or to access the pins of the target microcontroller on the Xplained Pro boards.

4. Hardware User's Guide

4.1 Electrical Characteristics

T10 Xplained Pro can be connected to several Xplained Pro MCU boards and manually connected to other hardware. The Xplained Pro MCU board(s) that do not have 3.3V as the primary target voltage will read all ID devices on connected extensions to check if they support the target voltage before enabling it to the extension headers. The table below shows the static content written in the ID chip.

Table 4-1. T10 Xplained Pro ID Chip Content

Data Field	Content
Product name	T10 Xplained Pro
Minimum operation voltage	2.7V
Maximum operation voltage	5.5V
Maximum current	45 mA

See also 3.1 Hardware Identification System.

4.2 Headers and Connectors

4.2.1 Extension Headers

The T10 Xplained Pro implements three Xplained Pro Standard Extension headers (see 3.2.1 Xplained Pro Standard Extension Headers) marked with EXT1 in silkscreen. These headers make it possible to connect the board to an Xplained Pro MCU board with a capacitive touch-enabled microcontroller. The pinout definition for each extension header can be seen in the tables below.

Table 4-2. T10 Xplained Pro Extension Header 1

Pin on EXT1	Function	Description
1	ID	Communication line to the ID chip
2	GND	Ground
3	Y-Line-1	For slider CS100
4	Y-Line-2	For buttons CS101, CS102, CS103 and CS104
5	Not Connected	
6	Not Connected	
7	Not Connected	
8	Not Connected	
9	Not Connected	
10	Not Connected	
11	I2C _SDA	SDA for LED Driver
12	I2C _SCL	SDA for LED Driver
13	Not Connected	
14	Not Connected	

..........continued

Pin on EXT1	Function	Description
15	Not Connected	
16	Not Connected	
17	Not Connected	
18	Not Connected	
19	GND	Ground
20	VCC	Target Supply Voltage

Table 4-3. T10 Xplained Pro Extension Header 2

Pin on EXT2	Function	Description
1	Not Connected	
2	GND	Ground
3	X-Line-2	For slider CS100, button CS102
4	X-Line-1	For slider CS100, button CS101
5	X-Line-4	For slider CS100, button CS104
6	X-Line-3	For slider CS100, button CS103
7	Not Connected	
8	Not Connected	
9	Not Connected	
10	Not Connected	
11	Not Connected	
12	Not Connected	
13	Not Connected	
14	Not Connected	
15	Not Connected	
16	Not Connected	
17	Not Connected	
18	Not Connected	
19	GND	Ground
20	VCC	Target Supply Voltage

Table 4-4. T10 Xplained Pro Extension Header 3[1]

Pin on EXT3	Function	Description
1	ID	Communication line to the ID chip
2	GND	Ground
3	Y-Line-1	For slider CS100
4	Y-Line-2	For buttons CS101, CS102, CS103 and CS104

Pin on EXT3	Function	Description
..........continued		
5	Not Connected	
6	Not Connected	
7	X-Line-1	For slider CS100, button CS101
8	X-Line-2	For slider CS100, button CS102
9	X-Line-3	For slider CS100, button CS103
10	X-Line-4	For slider CS100, button CS104
11	I2C _SDA	LED Driver: Identify Touch state
12	I2C _SCL	LED Driver: Identify Touch state
13	Not Connected	
14	Not Connected	
15	Not Connected	
16	Not Connected	
17	Not Connected	
18	Not Connected	
19	GND	Ground
20	VCC	Target Supply Voltage

Note:
1. For use with MCU kits with single XPRO extension header.

5.   Application Flow

The following diagram shows the application flow. Touch measurement is performed at regular intervals. At the end of each measurement, the data is processed to find touch states. Depending on the touch states, the LEDs are updated.

6. Hardware Revision History and Known Issues

6.1 Identifying Product ID and Revision

When an evaluation board is connected to a computer with MPLAB running, an information window with the serial number is shown. The first six digits of the serial number contain the product identifier and revision. Information about connected evaluation boards is also shown in the window.

The same information can be found on the sticker on the bottom side of the PCB. Most kits have stickers that have the identifier and revision printed in plain text as A09-nnnn/rr, where nnnn is the identifier and rr is the revision. Boards with limited space have a sticker with only a data matrix code, which contains a serial number string.

The serial number string has the following format:

"nnnnrrsssssssssss"

n = product identifier r = revision

r = revision

s = serial number

The product identifier for the Water Tolerant Touch Surface kit is A09-3240.

6.2 Revision 1

Revision 1 of T10 Xplained Pro (A09-3338/01) is the initial released version. There are no known issues.

7. Revision History

Document Revision	Date	Comments
A	01/2020	Initial document release

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