Application Note

Resistive Touch Screen Control Based on MSPM0

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ABSTRACT

This application note describes using a MSPM0L1306 LaunchPad™ to control a 4-wire resistive touch screen through GPIO and ADC, which is more popular in applications. After getting the location, the MCU uploads the result to a PC through the back channel UART on the LaunchPad.

This application note provides detailed instructions for the resistive touch screen control based on MSPM0L1306 through GPIO and ADC. This document includes descriptions of the control methods, and key attentions in the development.

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Trademarks

1 Introduction

A resistive touch screen works by applying a voltage across a resistor network and measuring the change in resistance at a given point on the matrix where a screen is touched by an input stylus, pen, or finger. This consists of two transparent resistive layers made by ITO. The change in the resistance ratio marks the location on the touch screen. The two most popular resistive architectures use 4-wire or 5-wire configurations. The related software can be accessed at MSPM0L1306-RESISTIVE-TOUCH-APPSW.

2 Hardware Connection

Figure 2-1 shows the system block diagram. Use a resistive touch screen and a MSPM0L1306 LaunchPad in the setup.

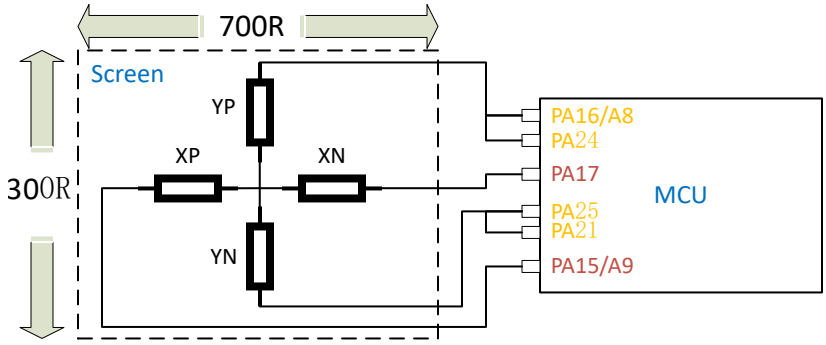

Figure 2-1. System Block Diagram

The real setup is shown in Figure 2-2.

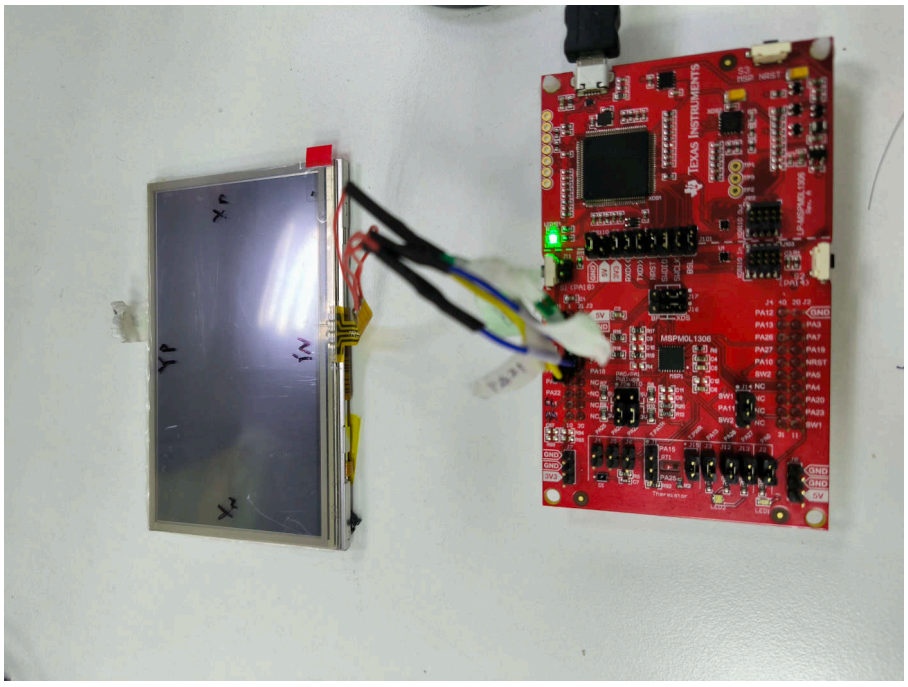

Figure 2-2. Real Hardware Setup

3 LaunchPad Setup

For the MSPM0L1306 LaunchPad, Table 3-1 shows the pins and pin functions. This can also be seen in Figure 2-1. For more details, refer to the SysConfig file in the software project.

Table 3-1. LaunchPad Pin Connection

Used Pin	Pin Function	Screen Control
PA16	GPIO; ADC channel 8	Y-axis positive direction
PA24	GPIO	
PA17	GPIO	X-axis positive direction
PA25	GPIO	Y-axis negative direction
PA21	GPIO	
PA15	GPIO; ADC channel 9	X-axis negative direction

The pins used in this demo are also connected to the peripherals on the LaunchPad. Remove these jumpers before doing tests as shown in Figure 3-1.

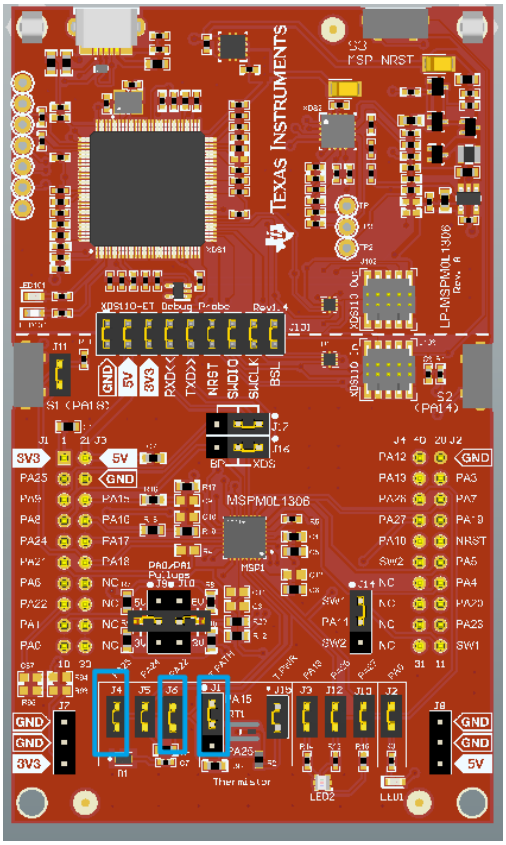

Figure 3-1. Removal of Launchpad Jumpers

4 Software Structure

The software project developed in CCS is shown in Figure 4-1. The software project mainly consists of three parts.

The resistive_detection part includes the IO and ADC control to get the Y-axis and X-axis.

The UART part mainly includes the write function based on UART protocol for M0 and uploads the measured results to the PC through the back channel UART.

The main part includes the highest system function code. After MCU powers on, the MSPM0 starts the resistive screen detection. If there is touch detected, then the resistive screen detection measures the voltage at Y-axis and X-axis and uploads the coordinate to PC.

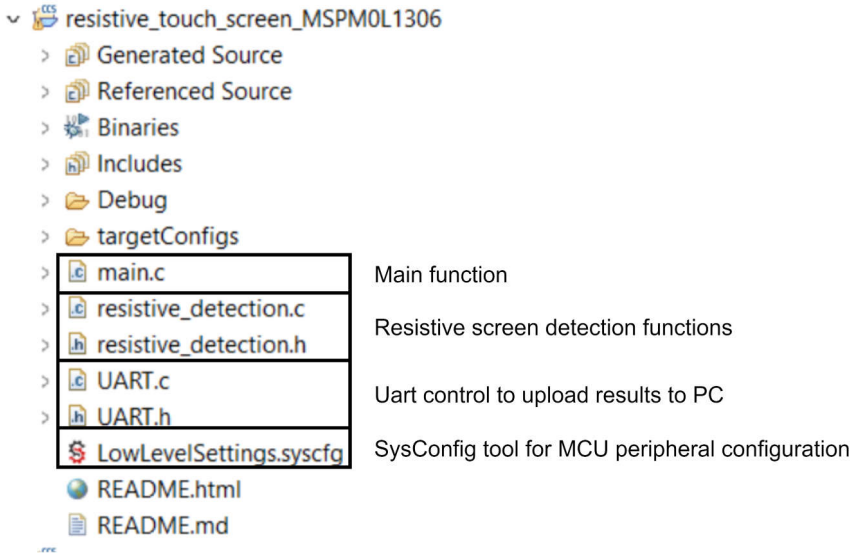

Figure 4-1. Software Project

5 Design Considerations

5.1 IO Selection Consideration

In Figure 2-1, two IOs are used for Y-axis direction drive and one IO is used for X-axis drive. There are two considerations to remember:

1. MSPM0 IO current output and input limitation
2. MSPM0 IO internal resistance

The resistive touch screen has 700ohm resistance in x-axis and 300ohm in Y-axis. Use 3.3V as the system power supply. That means users need 11mA to drive the resistance in X-axis, and need 4.7mA to drive the resistance in Y-axis. The MSPM0 L1306 current limitation is 6mA as shown in Table 5-1, and can be found in the **data sheet**. If users go beyond the specification, then permanent damage on MSPM0 can occur. That is why TI recommends to use two GPIOs to drive the Y-axis and one GPIO to drive the X-axis.

Table 5-1. Absolute Maximum Ratings

PARAMETER		TEST CONDITIONS	MIN	MAX	UNIT
VDD	Supply voltage	At VDD pin	–0.3	4.1	V
V_I	Input voltage	Applied to any 5V tolerant open-drain pins	–0.3	5.5	V
V_I	Input voltage	Applied to any common tolerance pins	–0.3	V_{DD} + 0.3 (4.1 MAX)	V
I_{VDD}	Current into VDD pin (source)	-40°C ≤ Tj ≤ 130°C		80	mA
	Current into VDD pin (source)	-40°C ≤ Tj ≤ 85°C		100	mA
I_{VSS}	Current out of VSS pin (sink)	-40°C ≤ Tj ≤ 130°C		80	mA
	Current out of VSS pin (sink)	-40°C ≤ Tj ≤ 85°C		100	mA
I_{IO}	Current of SDIO pin	Current sunk or sourced by SDIO pin		6	mA
	Current of HSIO pin	Current sunk or sourced by HSIO pin		6	mA
	Current of ODIO pin	Current sunk by ODIO pin		20	mA
I_D	Supported diode current	Diode current at any device pin		±2 (1)	mA

(1) Stresses beyond those listed under *Absolute Maximum Rating* can cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Condition*. Exposure to absolute-maximum-rated conditions for extended periods can affect device reliability.

MSPM0 internal IO resistance causes an offset on the resistive screen detection. For some high-resolution applications, this is not acceptable. If users want to reduce the influence, then there are two methods to further improve performance.

1. Add more IOs to drive the screen to spread the load current to more IOs pins.
2. Add ADC to both positive and negative axis IOs. Directly measure the voltage assigned to the IO internal resistors when driving the screen.

5.2 Y-axis and X-axis Measurement Method

The touch detection method is shown in Figure 5-1. When there is human touch, the detection method connects the resistive layers to the top and bottom.

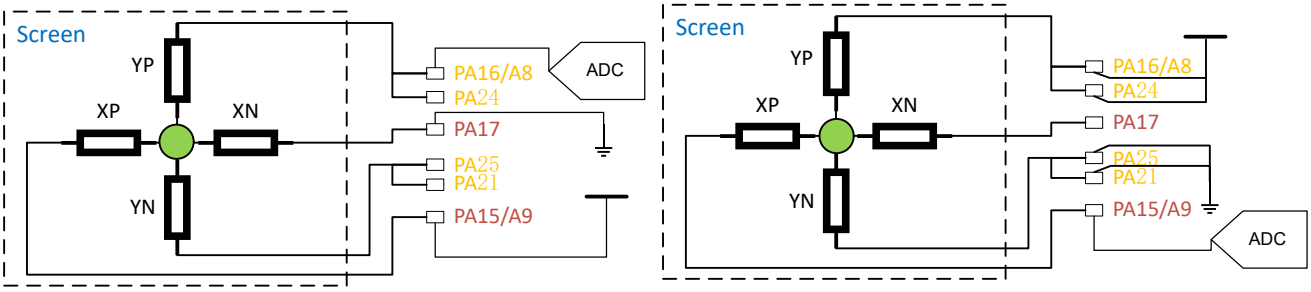

Figure 5-1. Measurement Setup

For the X-axis detection, set PA17 to output high and PA15 to output low. Set other pins to be analog functions (Hiz mode). Then, enable the ADC channel at PA16 to do the measurement.

For the Y-axis detection, set PA16 and PA24 to output high and PA25 and PA21 to output low. Set other pins to be analog functions (Hiz mode). Then, enable the ADC channel at PA15 to do the measurement.

After getting the voltage, the ADC does an oversampling to reduce the noise and directly use the ADC result as the coordinate and output to UART communication.

5.3 Touch Detection Method

The reason why touch detection is used is that problems can occur if the measurement method is used to do the detection.

When the resistive layers are not connected, the ADC is floating. When there is no touch, the result is strongly affected by the noise coupled from IO switch. That means ADC constantly outputs a fixed coordinate. When touch happens, a resistance is included between two resistive layers, which is very high when the touch is very weak. This also generates disturbance on the ADC output.

The MSPM0 setup is shown in Figure 5-2. Set the Y-axis to positive IO and Y-axis to negative IO for all outputs high when doing the detection. In this demo, ADC is used to do the measurement. For low-power requirement, users can use GPIO instead and paired with the wake-up function.

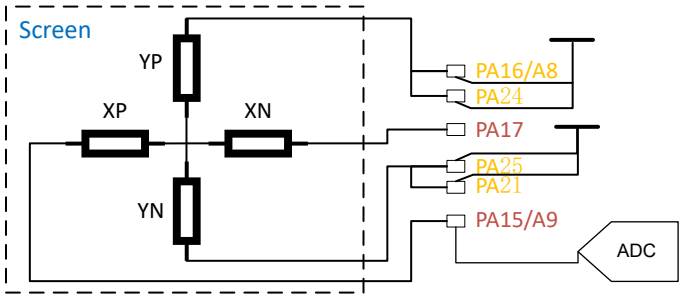

Figure 5-2. Touch Detection Setup

Use ADC to do the detection to filter the low-pressure condition for a touch action. TOUCH_DETECTION_THD in resistive_detection.h is used to do this. The MSPM0 ADC is configured in 8-bit mode, which means the max output counter is 255. Users can slightly adjust this parameter value to check when to release the detection signal.

```
resistive_detection.h
1 #ifndef RESISTIVE_DETECTION_H_
2 #define RESISTIVE_DETECTION_H_
3
4 #define X_ADC_CHANNEL       DL_ADC12_INPUT_CHAN_9
5 #define Y_ADC_CHANNEL       DL_ADC12_INPUT_CHAN_8
6
7 #define TOUCH_DETECTION_THD     250
8
9 #include "ti_msp_dl_config.h"
10
11 uint8_t readTouchX(void);
12 uint8_t readTouchY(void);
13 bool touchIODetection(void);
14 void touchIOReset(void);
15 uint8_t ADC_sample(uint32_t adc_channel);
16
17 #endif /* RESISTIVE_DETECTION_H_ */
```

Figure 5-3. Touch Detection Threshold

6 Evaluation Steps

1. Calculate the IOs needed by following the instructions in Section 5.1 .
2. Perform the connection between MSPM0L1306 LaunchPad and the touch screen following the instructions in Section 2.
3. Install Code Composer Studio™ (CCS) on the computer and load the code example.
4. After touching the MSPM0, the result is uploaded to the PC through the back channel UART as shown in Figure 6-1. The coordinate is only updated when there is touch.

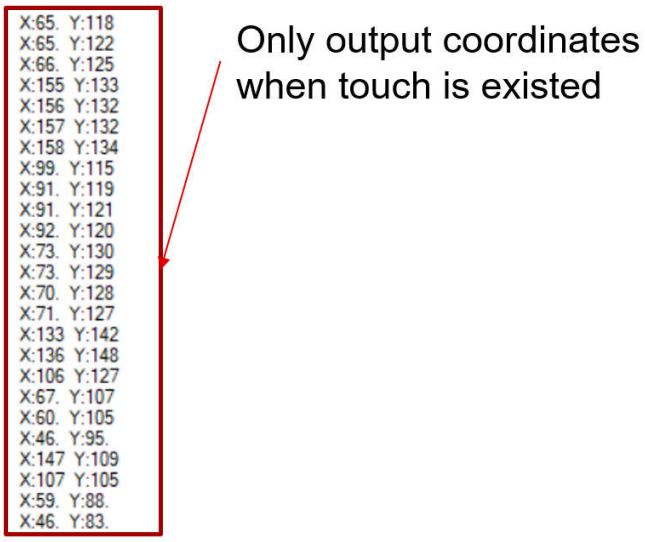

Figure 6-1. Run Time Results

5. Adjust the TOUCH_DETECTION_THD and detection frequency according to the experience.

7 Summary

This application note provides detailed instructions for the resistive touch screen control based on MSPM0L1306 through GPIO and ADC. With the descriptions of the control methods, key attentions in the development and software example code, users can migrate the resistive touch design to other MSPM0 easily.

8 References

- Texas Instruments, MSPM0L1306-RESISTIVE-TOUCH-APPSW

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