
Apply TI TSC for Various and Multiple Functions

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ABSTRACT

This application report presents several examples showing how a touch screen controller (TSC) from Texas Instruments provides a variety of functions such as graphs, scroll bars, pressure buttons, and analog dials. A simple resistive TSC can be used to achieve all of these functions as long as they are not activated simultaneously. This application report demonstrates a few simple examples how these can be implemented in software.

1 Introduction

In today's world, the touch sensor, also known as a touch screen or touch panel, is used in many different fields and applications. It has become one of the most popular tools for human-machinery and /or human-computer interfaces. In more and more devices and places, the touch sensor has become the sole interface .

Among the several different types of touch sensors or touch screens (TS), the resistive ones are currently the most widely used. TI provides a family of resistive touch screen controller (TSC) devices to control the resistive TSs, which include: ADS7843, ADS7845, ADS7846, TSC2000, TSC2003, TSC2046, and the latest new devices: TSC2004, TSC2005, TSC2006, TSC2007, and TSC2008. For the performance and digital interface of these devices, see the relevant data sheets on the TI Web site.

With a TI TSC device, a user can obtain the 2-dimensional (X-axis and Y-axis) or 3-dimensional (X-axis, Y-axis, and Z-axis) data that indicates or represents the touch position (X and Y) and pressure (Z) on the TS.

The most common usage of a touch screen system, including a TS and a TSC, is to locate the touch position so as to obtain the X, Y, and Z data. With this data, users can obtain a graphic view of the finger or stylus touch and its traces. An example is shown in [Figure 1](#), where the motion on the TS is translated into pixels on the picture.

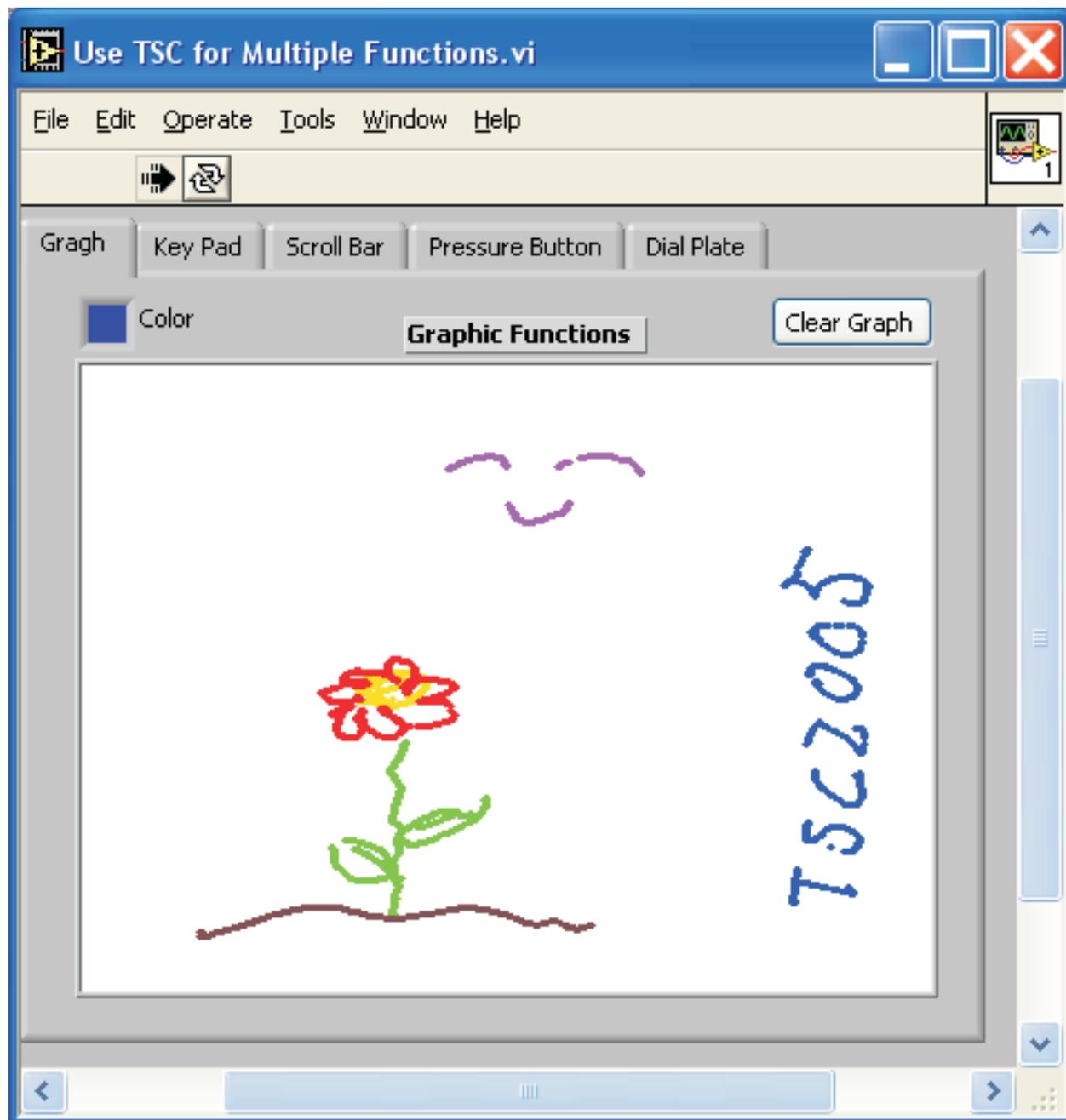


Figure 1. Use TSC Data for Graph and Position

Besides locating touching positions, the touch data and its other mathematical expression can be further used in various other applications, and to perform various and multiple functions/tools/devices. This application report presents several simple examples for the user's reference.

2 Use TS as Multiple Scroll Bars

A scroll bar can be used to continuously move and adjust various physical volumes, values, or parameters, such as the multiple audio EQ bars.

The finger or stylus moving direction on a TS can be sensed and computed to generate multiple virtual *scroll bars* as shown in [Figure 2](#).

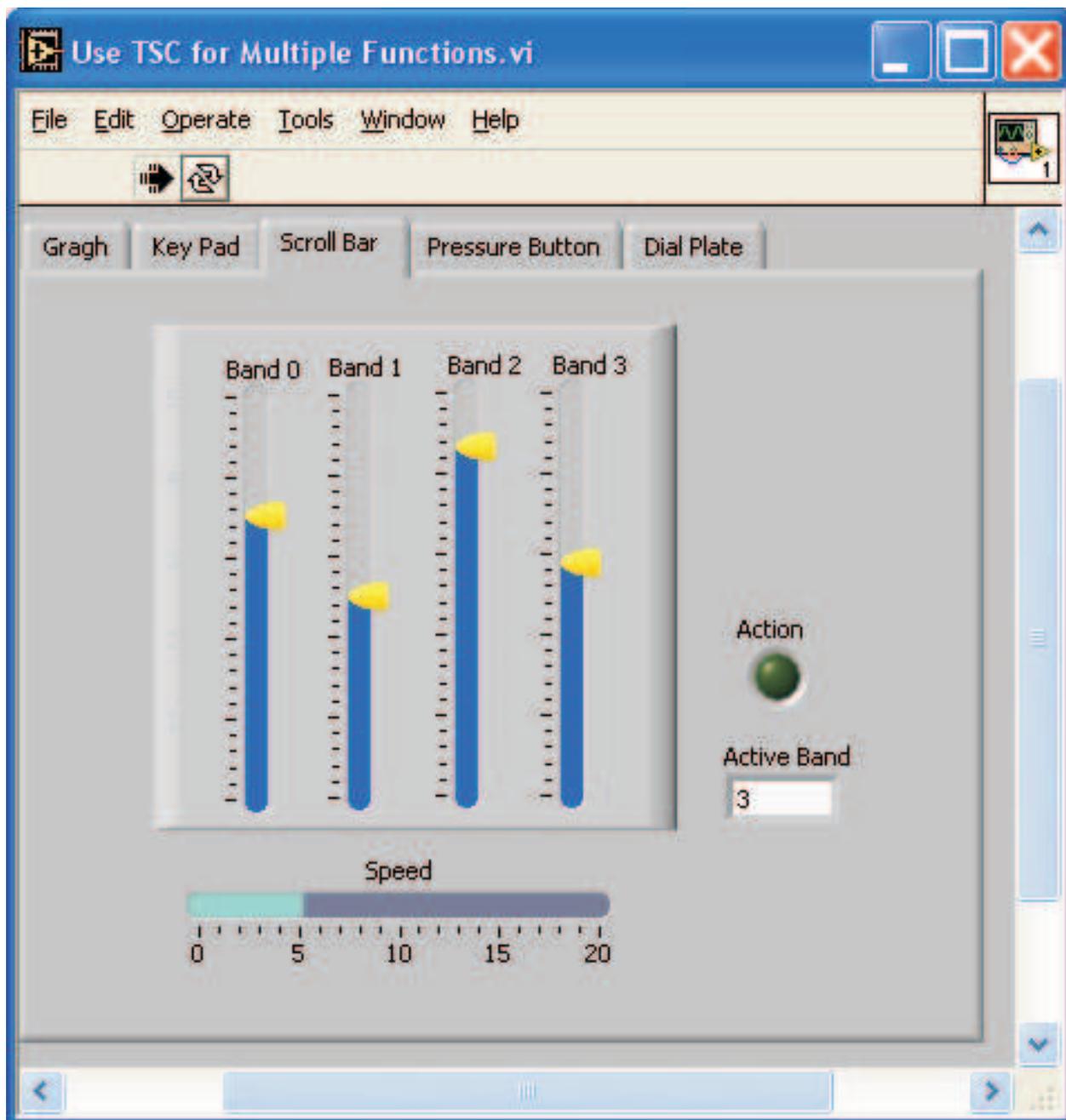


Figure 2. Use TSC Data for Scroll Bars

In the example of [Figure 2](#) are four scroll bars. When a touch occurs along the Y-axis within the first quarter of the X-axis, the Band 0 is active; when a touch moves on the 2nd quarter, the Band 1 is active; ..., and when a touch is on the last quarter, the Band 3 is active, as shown in [Figure 3](#).

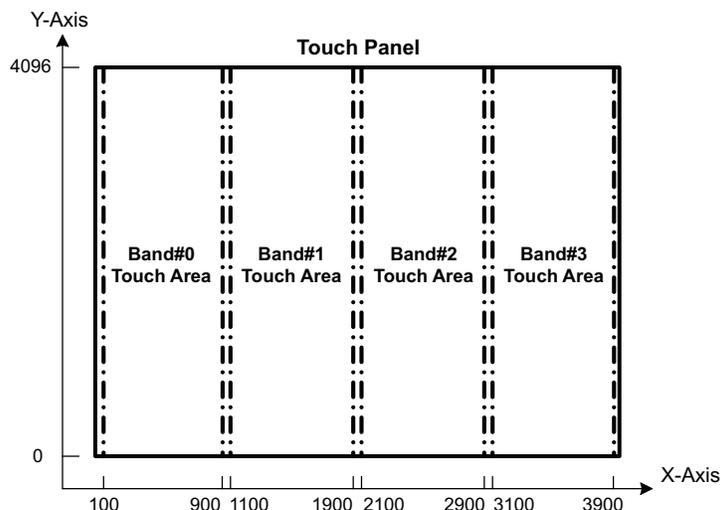


Figure 3. Divide TS or Touch Panel for Scroll Bars

You may *hold* or *drag* the yellow handle in [Figure 2](#) and move up/down along the TS's Y-axis or roll a finger up/down on a small area on the TS.

More scroll bars can be placed along the X-axis even though [Figure 2](#) shows only four bars as an example.

The *Action* green LED in [Figure 2](#) lights as soon as a touch on the TS is sensed; the *Active Band* indicator shows which of the four bands the touching occurs in, and the *Speed* slider beneath the bands can be used to select the bar moving rate.

To program the scroll bar in [Figure 2](#), the expression was used:

$$Y_{\text{bar}} = \begin{cases} Y_{\text{bar}} + Y\delta & \text{if } \Delta Y = Y(k) - Y(k-1) > 0 \\ Y_{\text{bar}} & \text{if } \Delta Y = Y(k) - Y(k-1) = 0 \\ Y_{\text{bar}} - Y\delta & \text{if } \Delta Y = Y(k) - Y(k-1) < 0 \end{cases} \quad (1)$$

Where Y_{bar} is the scroll bar position; and $Y\delta$ is the moving rate of the scroll bar, programmable through the *Speed* slider.

2.1 Use Touch on a Point as Pressure Button

The pressure on any single point of a touch screen can be used through the pressure button function, as shown in Figure 4.

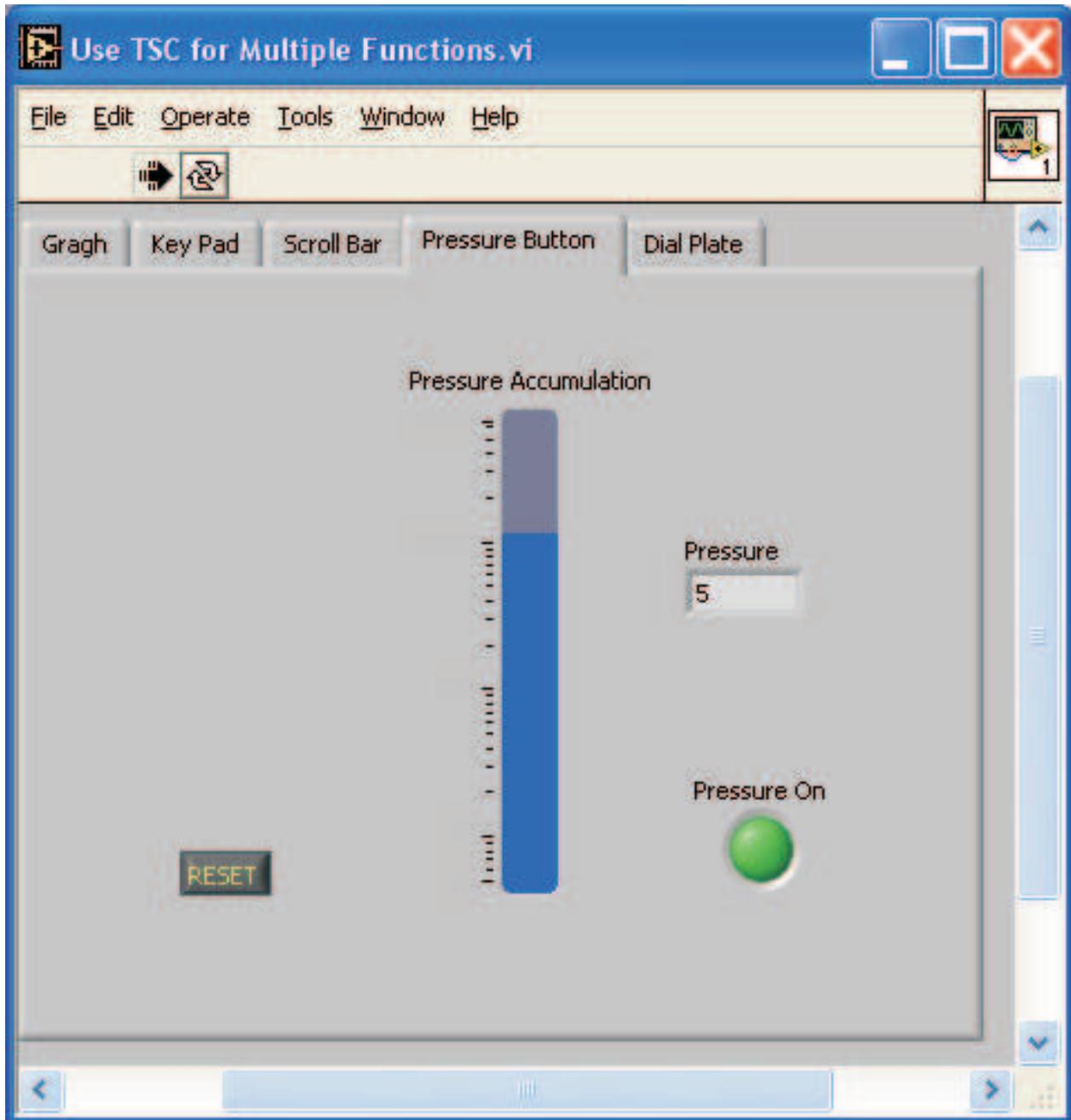


Figure 4. Use TSC Data for Pressure Button

In Figure 4, the instant **Pressure**, P , on the TS is summed and shown in the *Pressure Accumulation* indicator. The pressure accumulation P_{Accum} is obtained from:

$$P_{\text{Accum}} = P_{\text{Accum}} + P \quad \text{If } P > 0 \quad (2)$$

Because the indicator is a logarithmic scale, it seems that it rises slower as pressure goes higher. The reset bottom is used to reset the indicator to zero.

The instant **Pressure** of a touch on the TS is indicated in the *Pressure* box of [Figure 4](#) and is calculated from:

$$P = A - B \times R_{\text{TOUCH}} \quad (3)$$

where the A and B are two constants that convert the measured data to the proper pressure unit. In this example, A=5 and B=9 were used. And the R_{TOUCH} in [Equation 3](#) was obtained from:

$$R_{\text{TOUCH}} = R_{X\text{-plate}} \times \frac{X_{\text{position}}}{4096} \left(\frac{Z_2}{Z_1} - 1 \right) \quad (4)$$

which is the pressure measurement equation, as described in the TI TSC data sheet. See a TI touch screen data sheet for a detailed explanation of [Equation 4](#).

In [Figure 4](#), the green LED, labeled *Pressure ON*, indicates a pressure has been detected. The LED is ON whenever a touch is on the TS, and OFF when releasing.

Any one point on a TS can be designated as a pressure button.

2.2 Use Area Rotation Touch as Dial

Finger tip rotating, clockwise or counter-clockwise, on the top of a TS can be sensed and used to simulate an analog dial, as shown in [Figure 5](#).

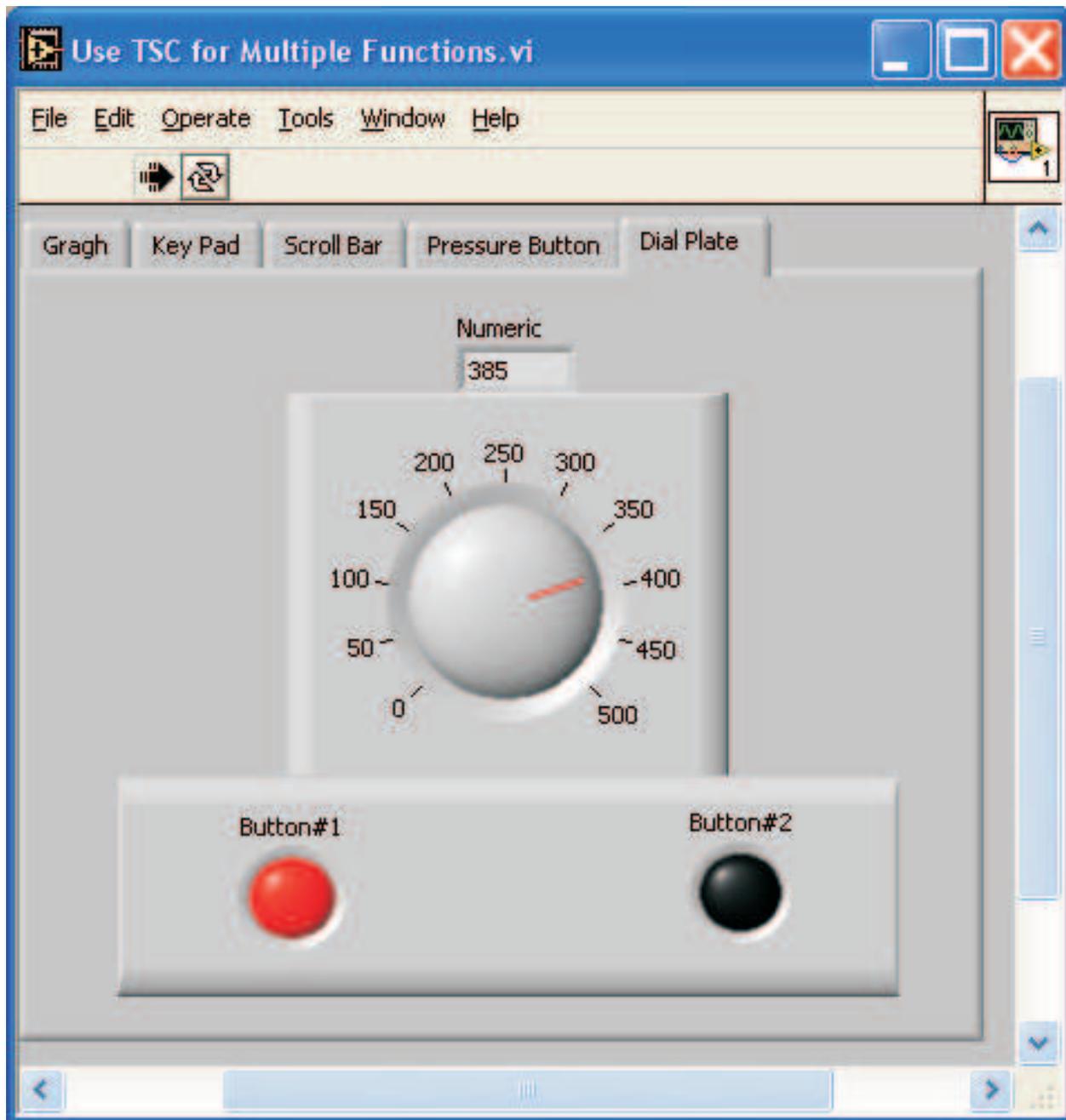


Figure 5. Using TI TSC Data for Multiple Virtual Dial Panel/Knob and Switch/Bottom

In [Figure 5](#), a dial is *located* at the center of the TS. To perform the *virtual* analog dial function, the rolling angle, or α of the dial is calculated from:

$$\alpha = \arctan\left[\frac{Y - Y_0}{X - X_0}\right] \quad (5)$$

Where $Y_0 = X_0 = 2048$, the center location of the dial.

The dial needle position, P_{dial} , has been programmed as an inverting proportional function of $\Delta\alpha$ or the differential of α , as expressed by Equation 6:

$$P_{\text{dial}} = \begin{cases} P_{\text{dial}} - P\delta & \text{if } \Delta\alpha > 0 \\ P_{\text{dial}} & \text{if } \Delta\alpha = 0 \\ P_{\text{dial}} + P\delta & \text{if } \Delta\alpha < 0 \end{cases} \quad (6)$$

Where $\Delta\alpha = \alpha(k) - \alpha(k-1)$. When the α increases (turning the dial counter-clockwise), P_{dial} decreases; if α decreases (turning clockwise), P_{dial} increases.

Additionally, two switching buttons are located under the dial in the Figure 5; they can be turned ON or OFF. Touching the left-bottom corner of the TS, the Button#1 is switched ON (red) or OFF (black); touching the right-bottom corner, the Button#2 is turned ON (green) or OFF (black). Thus, a touch becomes a switcher and can be used as a Boolean or digital device, such as a power ON/OFF switcher, a Start/Stop button, and so on.

Figure 6 shows the dial and buttons position on the screen, designated for this particular example.

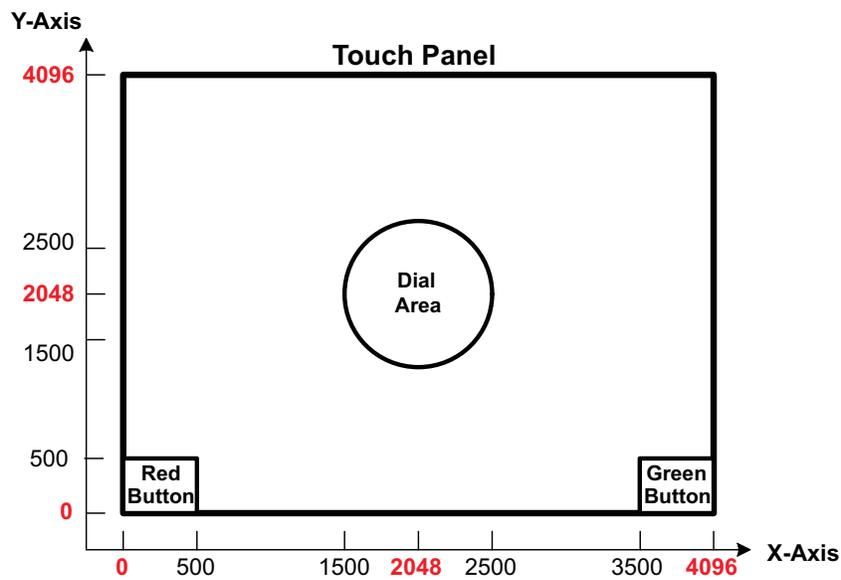


Figure 6. Divide Touch Panel for Multiple Functions

As one can see from these illustrations, there are spare areas on the TS that can be used as more switches, buttons, dials, bars, and other devices/parts, as is discussed in the next section.

2.3 Use One Screen for Multiple Functions

The foregoing examples used one (or two) function with one TS. Obviously, a TS can be divided into many areas/points to perform multiple functions. As an example, Figure 7 shows dividing a single screen into sections to perform all multiple functions previously discussed.

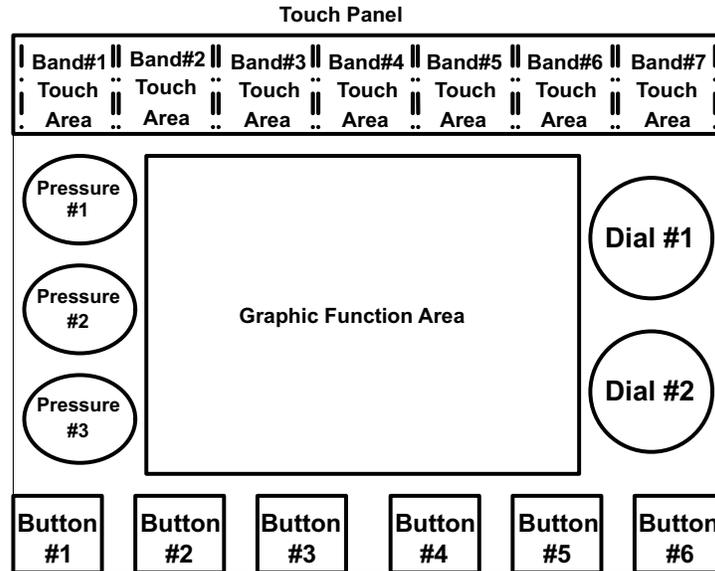


Figure 7. Diving One Screen for Multiple Functions

3 Conclusions

This application report presents examples that have been programmed, applied, and tested on a TI TSC2005EVM-PDK set.

By using simple differential (scroll bar or dial), integrate (pressure accumulator), or trigonometric (dial) expressions of the touch data X, Y, and/or Z, a variety of *virtual* tools/devices can be generated and applied, with a resistive TS controlled under a TI resistive TSC.

Users can use a single TS, by programming multiple software tabs, to perform many different functions, and/or divide the panel into many different areas for these multiple functions.

To obtain the foregoing functions in demonstration software, which have been tested on a TI TSC2005EVM-PDK and can run on your personal computer, send a request to:

dataconvapps@list.ti.com

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