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DE REF #308

iCE65 as Touch Screen Controller

Overview

A touch screen is a display which can detect the location of touches within the display area. This design example demonstrates the use of SiliconBlue iCE FPGAs as a touch screen controller for use with low power handheld devices.

Description

A touch screen is a display which can detect the location of touches within the display area, which allows the display to be used as an input device, removing the keyboard and/or the mouse as the primary input device for interacting with the display's content. Such displays can be attached to computers or handheld devices or, as terminals, to networks. There are many types of touch screens like resistive type, capacitive, infrared type, and strain gauge type etc.. The touch screen employed in this design example is of resistive type. This type of touch screen is widely used in many types of designs. Their construction is simple, their cost is low, and their operation is well understood by users. Although clarity is not as good as with other touch screen types, resistive screens are very durable.

A resistive touch screen panel is composed of several layers. The most important are two thin metallic electrically conductive and resistive layers separated by thin space. When some object touches this kind of touch panel, the layers are connected at certain point; the panel then electrically acts similar to two voltage dividers with connected outputs. This causes a change in the electrical current which is registered as a touch event and sent to the controller for processing. When measuring press force, it is useful to add resistor dependent on force in this model -- between the dividers.

A resistive touch panel output can consist of between four and eight wires. The positions of the conductive contacts in resistive layers differ depending on how many wires are used. When four wires are used, the contacts are placed on the left, right, top, and bottom sides. When five wires are used, the contacts are placed in the corners and on one plate.

4 wire resistive panels can estimate the area (and hence the pressure) of a touch based on calculations from the resistances. A touch on the touch screen can be defined by three parameters. The first and second parameters are X- and Y-position. The third parameter relates to "touch pressure" and allows the touch screen to differentiate between finger and stylus contacts.

This design example makes use of a digitizer chip (TSC2046 from Texas Instruments) is used to convert the analog signal levels from the touch panel to digital form. It features a Successive Approximation Register (SAR) ADC and has built-in switches to switch touch screen electrodes between being driven and being assigned to input to the ADC. More information may be obtained from the TSC2046 data sheets. The various parameters for deciphering the location of a touch can be retrieved from the digitizer by sending appropriate control words using its SPI interface. A pen interrupt signal, which is an output from the digitizer chip, goes low whenever the screen is touched. This signal can be used to inform an external system about a touch or release event, thereby allowing it to begin the ADC's sampling process by communicating with it.

Fig 1 shows the connection diagram of Touch Screen controller, Digitizer Chip and the Touch Screen.

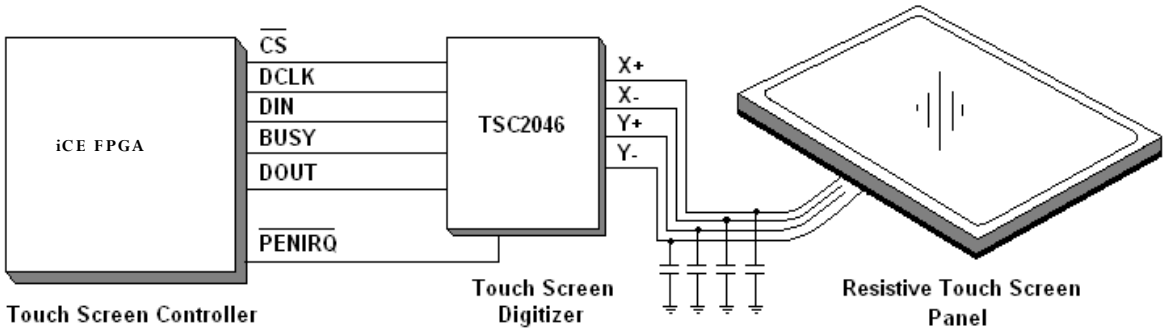

Fig 1: Connection diagram of Touch Screen controller

Implementation

The 4-wire resistive touchscreen controller block provides the coordinates of the touch point on the LCD panel. It constantly monitors the pen interrupt (penirq_n) signal from the TSC2046 touch screen digitizer and obtains the various parameter values from the ADC once the interrupt signal goes low. A settling time of 10ms is used to allow the various signal level from the touch panel to settle before the command words to obtain the ADC values are sent to the digitizer using its serial interface. Once the ADC values have been obtained, suitable arithmetics are performed to convert them into screen coordinates. The touch screen resolution used for this demo is 16x32 points for the entire screen All measurements are made using the differential mode of the ADC in order to eliminate errors due to power supply and touch panel resistance variations. The touch_bit, which is an output of the touch screen controller, becomes high whenever the screen is touched and remains high until the touch stimulus is removed. It is used to convey to the external systems that the coordinate values on the x_pos and y_pos buses are live values.

Fig 2 shows the high level block diagram of Touch Screen controller using iCE FPGA. Table 1 lists the pin description of this design example. Table 2 summarizes the post P&R resource utilization summary of this Design Example when implemented using iCE65 FPGA.

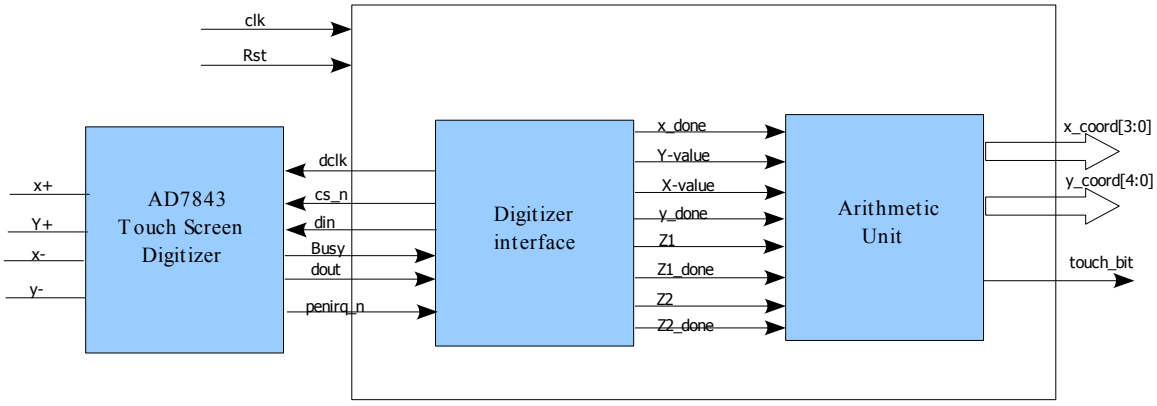

Fig 2: Block diagram of Touch screen controller

Pin	Direction	Description
rst	input	System reset
clk	input	System clock
penirq_n	input	Pen interrupt. active Low
dout	input	serial data input port
busy	input	Busy input from the digitizer
dclk	output	Clk input to the digitizer
din	output	serial data output port
cs_n	output	digitizer chip select. Active Low
touch_bit	output	goes high whenever active touch coordinates are available on the x_coord and y_coord buses
x_coord[3:0]	output	x coordinate bus
y_coord[4:0]	output	y coordinate bus

Table 1: Pin Description

Device	Logic Cells	IO Cells
iCE65L04-UCB284	146	17

Table 2: Resource Utilization

Conclusion

This demo application demonstrates the implementation of a touch screen controller on an iCE FPGAs. iCE FPGAs, due to their very low power capabilities, are ideal for implementing such applications used in the contexts of handheld and mobile devices where power saving is of paramount importance.

Disclaimer