Interfacing an Microsemi Fusion Programmable System Chip to a Four-Wire Resistive Touchscreen

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The Microsemi Fusion® field programmable gate array (FPGA) is well suited for controlling liquid crystal displays and interfacing to resistive touchscreen panels. As the world's first mixed signal FPGA, Fusion seamlessly integrates digital FPGA logic, Flash memory, a multi-channel 12-bit successive approximation register (SAR) analog to digital converter (ADC), and on-chip oscillator and power management circuits.

Touchscreen Basics

As illustrated in Figure 1, a four-wire resistive touchscreen panel consists of two flexible layers uniformly coated with a transparent resistive material and separated by an air gap. Electrodes placed along the edges of the layers provide a means for exciting and monitoring the touchscreen.

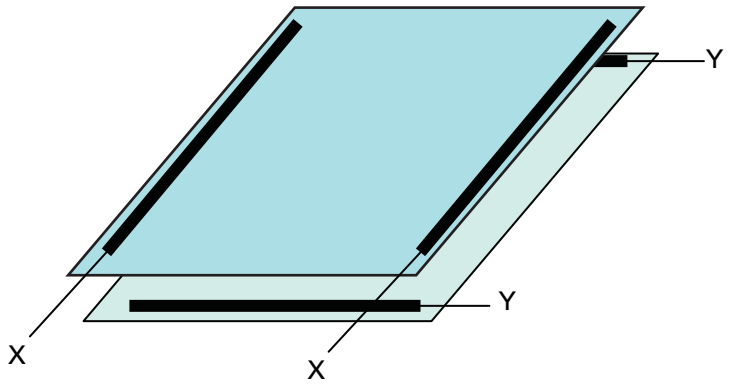

***Figure 1* • Structure of a Simple Four-Wire Resistive Touchscreen**

When the screen is touched, the layers make contact. If a reference voltage is applied across the electrodes in the X layer, a resulting voltage proportional to the horizontal position is measured on either Y electrode. Likewise, if the reference voltage is applied across the Y layer, then a voltage proportional to the vertical position can be measured on the X+ electrode. If the voltage applied across the layer is equal to the full scale reference voltage of an ADC, then position is directly indicated by the resulting ADC value.

It is also possible to estimate the touch pressure (contact area) by measuring the contact resistance between the X and Y electrodes. This is accomplished by first measuring the X and Y positions and then applying the reference voltage across the X– and Y+ electrodes and measuring the resulting voltage at the Y– electrode (Z). Knowing these three values, the touch pressure is estimated using EQ , where Rx and Ry are the total plate resistance and N is the number of ADC bits used in the analog to digital conversion.

$$R_{touch} = \frac{R_x X_{pos}}{Z} - \frac{R_x X_{pos}}{Z^N} - R_y + \frac{R_y Y_{pos}}{2^N}$$

EQ 1

Fusion Based Touchscreen Interface

Implementing the four-wire touchscreen interface using a Fusion device requires the use of one Analog Quad (three voltage inputs), an external 3.3 V reference/excitation voltage, four general purpose output pads from the FPGA logic, and four external MOSFET transistors. These are connected as shown in Figure 2.

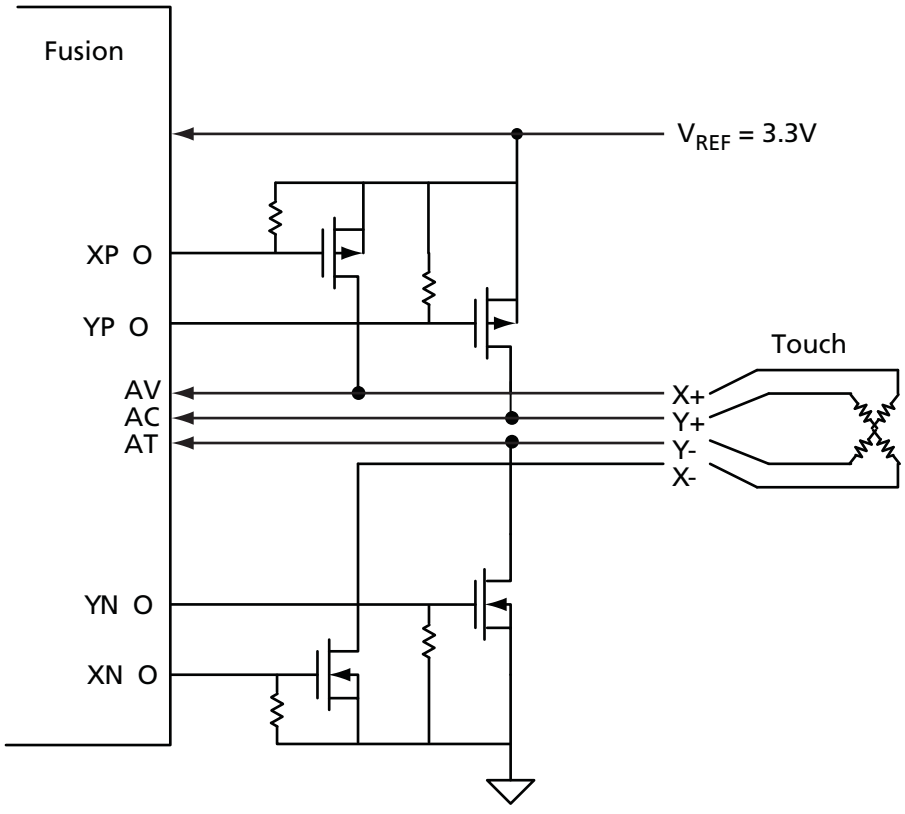

***Figure 2* • Fusion Connections to a Four-Wire Touchscreen**

A 3.3 V excitation voltage is used and this voltage is also applied to the external reference input of the Fusion device. In this case, the touchscreen inputs do not require prescaling support and can be configured as direct inputs. The analog inputs are configured to use 12-bit ADC resolution, and a settling time of 2 µs based on source impedance of Rxy = 1,000 Ω. These settings are configured via the Analog System Builder interface in the Microsemi Libero® System-on-chip (SoC) software Integrated Design Environment (IDE) EDA tool suite shown in Figure 3.

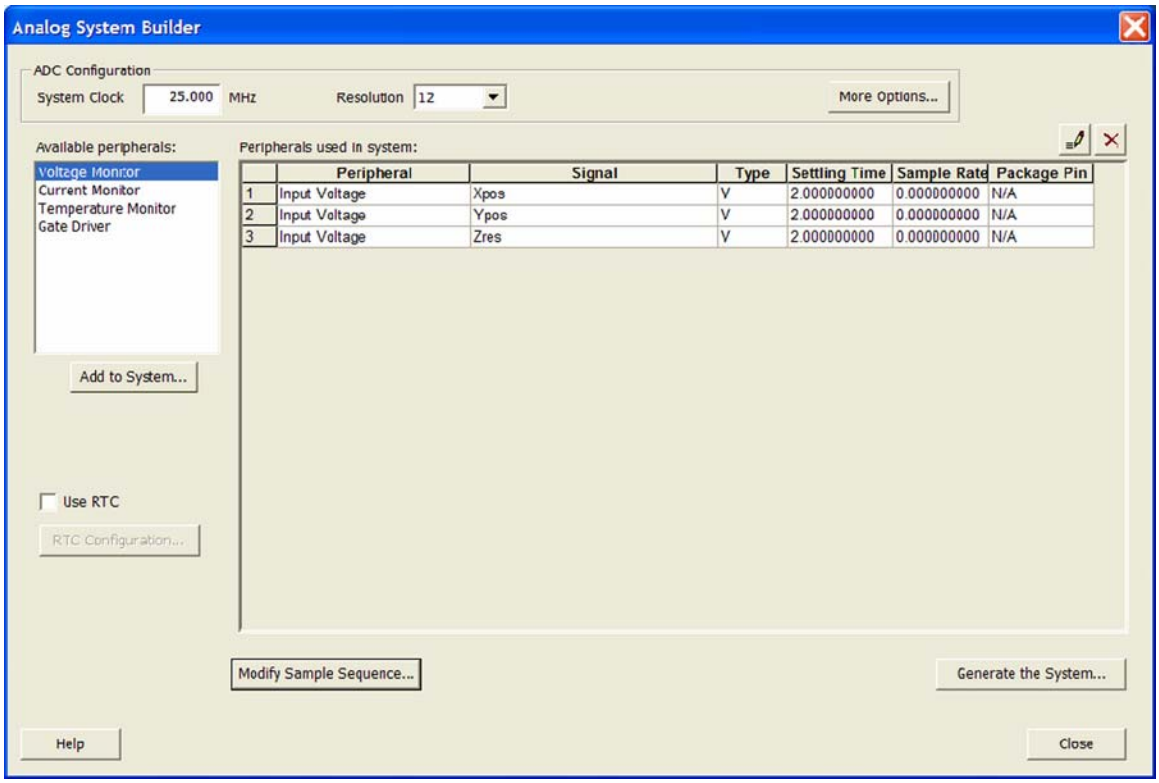

***Figure 3* • Analog System Builder Channel Configuration Window**

Once the input channels are configured, the Analog System Builder interface is used to establish jump sequences for the X position, Y position, and Z resistance measurements (Figure 4). Jump sequences are used rather than the main sequence so that user logic can establish settings on the external MOSFETs and then initiate the appropriate sampling sequence. If the FPGA logic also provides the display control functions, this arrangement will allow you to control the timing of display updates and touchscreen sampling to minimize the impact of analog noise caused by the digital switching of the liquid crystal display.

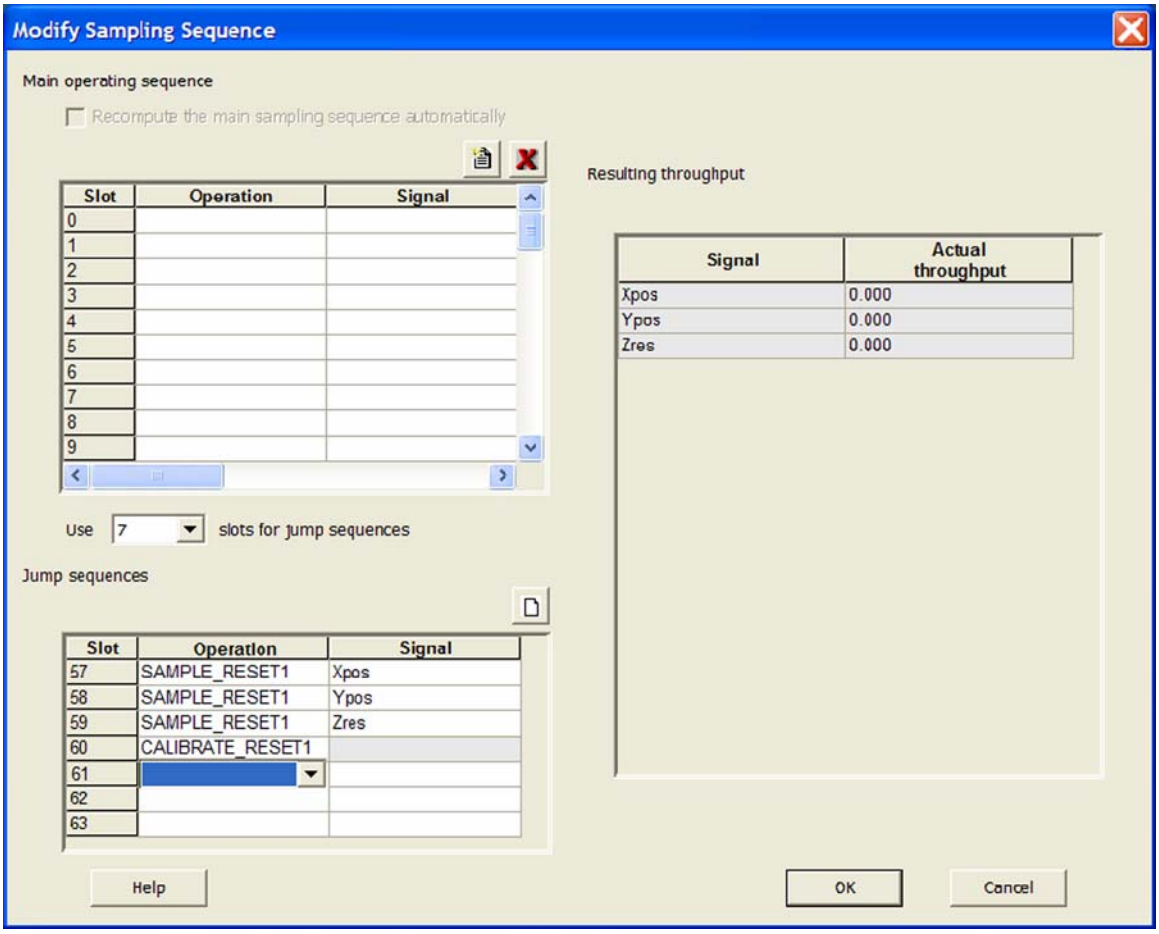

***Figure 4* • Analog System Builder Sequence Configuration Window**

With the analog system in place, user logic must be added to the design to control the MOSFETs and initiate the jump sequences. The state diagram in Figure 5 illustrates on example of the steps required to monitor the touchscreen and collect the position data.

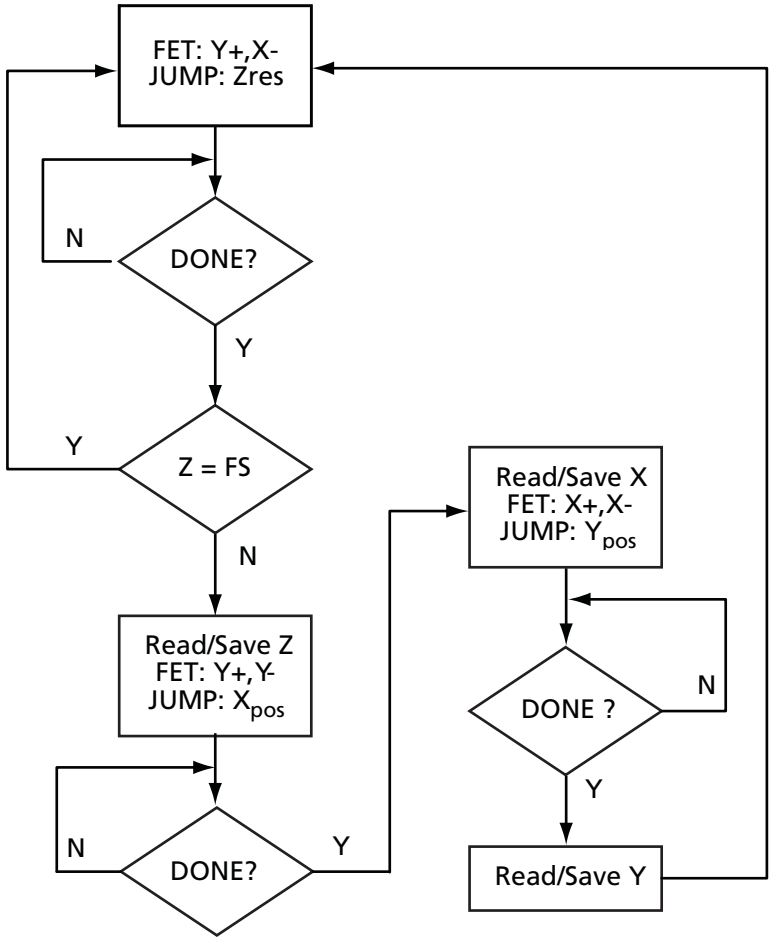

***Figure 5* • State Diagram for Touchscreen Monitoring**

In this case, the design continuously monitors the Zres value. Whenever the Zres value is less than the full-scale reading on the ADC, we know that the screen is being touched. When the screen is touched, the design proceeds to measure the X and Y position coordinates and then repeat the loop.

The details of any implementation will vary based on the specific electrical parameters of the touchscreen that is used and how the touchscreen is used in your application.

For more information on Microsemi Fusion FPGAs, contact your local Microsemi Manufacturer's representative.

Summary

Microsemi Fusion devices enable easy integration of touchscreen support into your programmable solution. With integrated analog resources and Flash memory, combined with the robust Flash FPGA architecture, Fusion enters a new era in programmable system chips.

List of Changes

The following table lists critical changes that were made in each revision of the document.

Revision	Changes	Page
Revision 1 (August2015)	Non-Technical Updates.	N/A
Revision 0 (August 2006)	Initial Release.	N/A

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