CAPACITIVE TOUCH SENSOR

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is an application under 35 USC 111 (a) and claims priority under 35 USC 119 from Provisional Application Ser. No. 60/539,832, filed Jan. 27, 2004 under 35 USC 111 (b). The disclosure of that provisional application is incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] This invention relates to touch sensors, and more particularly to capacitive touchscreens and to circuits for use and methods for use in capacitive touchscreens that can provide a control signal providing information about the location of a touch on the sensor.

[0004] 2. Introduction to the Invention

[0005] Touchscreens are commonly used as interfaces for computers and other electronic devices, such as hand held personal digital assistants, kiosks, games, point-of-sale devices, etc.

[0006] A capacitive touchscreen sensor is one type of sensor for a touchscreen that operates by capacitive shunting of current through a dielectric layer to a user's finger and then through the user's body to ground. Other grounded elements, such as a grounded stylus, may also be used. This type of sensor typically includes a capacitive sensing circuit with multiple electrodes, each producing an electric field across a touch sensitive area of the sensor. The sensing circuit can be adjacent to a transparent protective sensor substrate, e.g., glass. A touch near an electrode affects the electric field and creates a signal that can be detected by the sensing circuit. A set of electrical connections is made between the sensing circuit and a controller that resolves the signals to determine the location of the touch on the sensor. The coordinates of the location may then be communicated to another processor such as a host computer for further processing.

[0007] In a typical capacitive sensor, a stack including multiple transparent layers is used, including a substrate layer, a resistive layer, e.g., indium tin oxide (ITO), on top of the substrate, and a layer acting as a shield on the bottom of the substrate. Silver frit traces are a commonly used element to couple the resistive layer to detection electronics.

BRIEF SUMMARY OF THE INVENTION

[0008] The present invention relates to a capacitive touchscreen sensor. The touchscreen includes a plurality of electrodes distributed around a touch sensitive area of the touchscreen, and a control circuit connected to the plurality of electrodes, wherein the control circuit includes circuitry for measuring capacitance on the sensor, and provides a control signal indicating coordinates of a touch position on the screen.

[0009] In one aspect, the present invention provides a capacitive sensor having multiple electrodes, a resistive layer, and a circuit for charging the resistive layer and sensing capacitance on the layer. The circuit comprises multiple input/output connections to the screen and multiple sub-circuits, where one sub-circuit is associated with one electrode. Each sub-circuit includes a pair of switching elements, an energy storage element, and a detector. In each sub-circuit, a first switching element, when closed, connects an electrode to the energy storage element which is in turn connected to ground. The second switching element, when closed, connects the energy storage element to the detector. In a preferred embodiment, the first switching element is closed and the second switching element is open when the electrodes are being charged to a set voltage level, and the first switching element is open and the second switching element is closed when the detector is measuring an energy storage level of the energy storage device.

[0010] In another aspect, the present invention provides a method for measuring a location of a touch to a capacitive sensor, wherein the sensor has multiple electrodes, a resistive layer, and a circuit for charging the resistive layer and sensing capacitance on the layer. The circuit includes multiple input/output connections, and multiple sub-circuits, where one sub-circuit is associated with one electrode. Each sub-circuit includes a pair of switching elements, an energy storage element and a detector. The method includes using a first switching element of each sub-circuit, when closed, to connect an electrode to an energy storage element which is in turn connected to ground, and using a second switching element, when closed, to connect the energy storage element to a detector. The method includes charging an electrode to a set voltage level when the associated first and second switching elements are closed and opened, respectively, and measuring energy in the energy storage element with the detector when the first and second switching elements are opened and closed, respectively.

[0011] In a further aspect, the present invention provides a capacitive sensor having multiple electrodes, a resistive layer and a circuit for charging the resistive layer and sensing capacitance on the layer, wherein the circuit includes a detector for measuring charge, and an analog to digital converter for digitizing the output of the detector. The circuit includes a capability for automatically setting a gain control by using a plurality of most significant bits of the analog to digital converter to determine when a detector is saturated.

[0012] In another aspect, the present invention provides a capacitive sensor having multiple electrodes, a resistive layer and a circuit for charging the resistive layer and sensing capacitance on the layer, wherein the circuit includes a plurality of detectors for measuring charge and only one power supply having a single polarity, and operates using a virtual ground set to a voltage greater than 0V but less than 5V. In a preferred embodiment, a digital potentiometer is used to tune the voltage of reference inputs to the charge detectors so that the potential present on all of the electrodes is the same.

[0013] In another aspect, the present invention provides a method for detecting a touch on a capacitive touch sensor, wherein the method includes providing a circuit for charging and discharging the sensor through multiple electrodes electrically connected to the sensor. The circuit includes a sub-circuit corresponding to each electrode. The method includes first charging all electrodes to a first potential and measuring an extent of charge for some of the sub-circuits at a desired time after charging. The method then includes