conjunction with the drawing figures, in which like reference numerals are carried forward.

[0016] The invention solves the problem of the complexity of touch screens and the limited utility of fixed buttons by providing a simple touch screen button apparatus. A first layer of transparent insulator has a trace of transparent conductive material disposed thereon. The conductive material, while conductive in thick, wide layers, provides substantial electrical resistance when disposed as a thin trace. Second insulating layer likewise has a layer of transparent conductive material on it. The two layers with transparent conductor are separated by a separator layer of insulating material. The separator layer has openings formed therethrough corresponding to button locations. A voltage potential is applied to the conductive trace, and when a user presses the first and second insulating layers together through one of the openings in the separator layer. The voltage is divided along the trace on the first layer, producing different voltage levels at the different button locations. These different voltage levels are read via the second layer and the conductive material disposed thereon. The voltage level change is read by a controller, and used to determine which button location was pressed by the user.

[0017] Referring now to **FIG. 1**, there is shown an exploded isometric view of a touch screen assembly **100**, in accordance with the invention. The assembly comprises a first outer layer of transparent insulator **102** having a first trace of transparent conductor **104** disposed thereon on an inside surface. The insulator material may be one of a variety of materials such as, for example, polymer sheet, or polyester film, such as Mylar™ by the DuPont Corporation, which is typically classified by one skilled in the art as a Polyethylene Terephthalate, or PET. The transparent conductor is preferably indium tin oxide (ITO), which is suitably transparent in thin layers. Furthermore, the conductor layer is less conductive than conductive-materials such as copper, for example, and provides significant electrical resistance. Along the trace, at locations corresponding to button locations, the trace may be enlarged to form pads or pad segments, such as pad segment **106**. The conductor trace preferable starts and ends on tab **108** so as to facilitate electrical connection to control circuitry. The assembly further comprises a second outer layer of transparent insulator **110** having a second trace of transparent conductor **112** disposed thereon on an inside surface. For the second outer layer, the transparent conductor may be arranged to match the path and shape of the trace on the first layer, or it may simply be over the entire layer, so long as there is a contiguousness to it that covers the button locations. Preferably, however, the second trace also has pad segments **114**. As with the first trace on the first outer layer, the second trace preferable starts and ends on a tab **116** to facilitate electrical connectivity to control circuitry. Disposed between the first and second outer layers is a separator layer **118** formed of transparent insulator disposed between the first and second outer layers and having a plurality of openings **120** positioned therethrough, each of the openings corresponding to one of a plurality of button locations. To hold the three layers together, an adhesive may be disposed on both major surfaces of the separator layer. The two outer layers are then aligned with the separator layer. When so assembled, the conductor layers may be pressed into contact by a user by pressing on the second outer layer at one of the button locations.

[0018] Referring now to **FIG. 2**, there is shown an electrical schematic **200** of a touch screen apparatus and detection circuitry, in accordance with the invention. Shown here are segments of the first and second conductor layers **104**, **112**. The pad segments **106** and **114** are aligned at button locations so that when they are pressed together, as indicated by arrow **202**, for example, they make electrical contact. Since the outer layers and the conductor trace material is transparent, the assembly can be disposed over a display **203** and an image or character **205** may be displayed on the display and seen by a user through the assembly at the button location.

[0019] To detect the press of a user, the first conductive trace **104** has a voltage potential V+ applied to it. Because it is resistive, the voltage at any point along the trace reduces as the position gets closer to the ground potential. The second conductive trace **112** is connected to a sensing circuit, such as, for example, an analog to digital (A/D) converter **204**. The sensing circuit has a high impedance input to which the second conductive trace is connected. When the second conductive trace makes contact with the first conductive trace, the voltage potential at the contact point is sensed by the sensing circuit. Because the sensing circuit has a high impedance input very little current flows through the second conductive trace **112**, and therefore very little voltage drop is evident between the contact point and the input of the sensing circuit. As such, the voltage at the input of the sensing circuit is substantially equal to the voltage at the contact point. Since the voltage on the first conductive trace **104** decreases between the point where the voltage potential V+ and the reference or ground level, the voltage evident at the various pad segments is different. At each pad segment there is a range of voltages that may be evident, depending on where within the pad segment contact is made. In the preferred embodiment the A/D converter converts the voltage at the input of the A/D to a digital value. The digital value is output to a controller **206** which occasionally looks at the value output by the A/D converter, and determines if the value is different than the value that would be read when the two conductive traces are not pressed together and the assembly is in an idle state. When the controller detects a change in state from the idle state, the controller compares the value, or an average value produced by averaging two or more readings, with a table in a memory **208**. As will be described herein, the table defines ranges of values, each different range of values corresponding to a different button location, indicating that the user has pressed at the corresponding button location. The table may also indicate the image or character to be displayed on the display **203**, or on a secondary display **210**. Alternatively the table may indicate an action for the portable electronic device to take, such as, for example, displaying a list of phone numbers. The sensing of which button location is pressed by the user can be accomplished in a variety of ways besides the preferred means described here. For example, a comparator may be used to sense a change from the idle state, and the output of the comparator may be connected to an interrupt input of the controller. Then the controller would only read the value of the A/D upon receiving an interrupt indicative of a button press. Alternatively, a series of window comparators may be used with one set for each button location. The output of each set of window comparator would change from an idle state to an active state when the corresponding button is pressed. Each output would be connected to a