SUMMARY OF THE INVENTION

[0018] The foregoing objects are achieved by the invention in which a personal electronic device includes a programmable display and a programmable keypad, wherein at least one of the programmable display and the programmable keypad includes a capacitive touch sensor and an EL panel in a unitary structure. A conductive layer shields the capacitive touch sensor from the EL panel and can be a separate layer or be incorporated into either the capacitive sensor or the EL panel. The conductive layer includes antimony tin oxide (ATO), other conductive oxide, or a conductive polymer, such as Orgacon™ 3010.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] A more complete understanding of the invention can be obtained by considering the following detailed description in conjunction with the accompanying drawings, in which:

[0020] FIG. **1** is a perspective view of a cellular telephone having a backlit display and capacitive sensor constructed in accordance with the invention;

[0021] FIG. **2** is a perspective view of a personal electronic device having a backlit display and capacitive sensor constructed in accordance with the invention;

[0022] FIG. **3** is a cross-section of a backlit display and capacitive sensor constructed in accordance with the invention;

[0023] FIG. **4** is a plan view of a portion of the display and sensor illustrated in FIG. **3**;

[0024] FIG. **5** is a plan view of a rotary capacitive sensor;

[0025] FIG. **6** is plan view of another rotary capacitive sensor;

[0026] FIG. **7** is a plan view of a touch pad having corner connections to sense circuitry;

[0027] FIG. **8** is a cross-sectional view of a back lit capacitive sensor constructed in accordance with another aspect of the invention; and

[0028] FIG. **9** is a cross-sectional view of a back lit capacitive sensor constructed in accordance with an alternative embodiment of the invention.

The figures are not drawn to scale but merely illustrate various aspects of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0029] FIG. **1** is a perspective view of cellular telephone ("cellphone") **10**, which includes touch-tone keypad **11** constructed in accordance with the invention. Cellular telephone **10** has several additional backlit areas, including display **12**, and function keys **13**, **14**, and **15**. While all such areas could be backlit by a single EL panel, at least two panels are preferred, one for the keypad and one for the remaining areas.

[0030] FIG. **2** is a perspective view of personal electronic device **20**, which can include cellphone circuitry, clock and calendar functions, audio-visual recording and playback, and data storage, individually or combined. The more functions provided, the more complicated a display and keypad become. Thus, it is preferable to provide a programmable display for specific functions with separate controls for generic functions such as power on-off, motion, scrolling, selection or highlighting. Again, depending upon the functions contained in device **20**, display **21** can be a fixed graphic overlay, a programmable liquid crystal display, or a programmable display using pixelated EL lamps. A liquid crystal display can include an overlay of a capacitive sensor.

[0031] Display **21** can provide a variety of images, such as an image of keypad **22**, an image of a numeric keypad, an image of a "QWERTY" or typewriter keyboard, messages, or a menu, in addition to graphics. Scrolling is effected by slider **23**, which is also a capacitive sensor. Central key **24** provides a selection function. All the keys in keypad **22** can be programmable, although at least some fixed function keys are preferred, such as a pair of keys for power on-off and a pair of keys for on-off hook, if cellphone capability is provided. In software terms, fixed keys trigger non-maskable interrupts of a microprocessor (not shown) within device **20**, thereby assuring that certain basic operations will be performed on demand.

[0032] FIG. **3** is a cross-section of a combined EL panel and capacitive touch sensor constructed in accordance with a preferred embodiment of the invention. Backlit sensor **30** includes substrate **31**, which is preferably a plastic sheet, such as polyethylene terephthalate (PET), having a thickness of 3-7 mils (0.076-0.178 mm). A substrate thickness of five mils (0.127 mm) or less is preferred for flexibility and, more importantly, a thin structure. As oriented in FIG. **3**, EL panel **32** is on the lower surface of substrate **31** and capacitive sensor **33** is on the upper surface of the substrate, forming a unitary structure. The individual layers will be describe as though the panel and sensor were being constructed from substrate **31** outward. The panel and sensor need not be made this way. For example, EL lamp **32** and capacitive sensor **33** can be made separately and laminated to substrate **31**. Lamination may require adhesive layers, which is not preferred because it increases thickness. Laminating with a tacky or partially cured layer is preferred.

[0033] Transparent conductive layer **34**, such as vacuum coated ITO, is on the lower surface of substrate **31**. Conductive layer **34** can cover substantially the entire substrate or be patterned, depending upon application. Insulation layer **35** overlies conductive layer **34** and is preferably a screen printed polymer resin. Conductive layer **36** forms a middle electrode and is preferably a screen printed conductive resin, such as Orgacon™ 3040 (Agfa-Gevært N.V.). Conductive layer **36** can be patterned, or not, as desired.

[0034] Phosphor layer **37** is preferably a screen printed polymer resin containing phosphor particles in suspension. Dielectric layer **38** overlies phosphor layer **37** and is preferably printed from polymer resin ink containing barium titanate in suspension. Conductive layer **39** is the rear electrode of EL panel **32** and is preferably screen printed from carbon bearing ink. Acrylic layer **40** overlies conductive layer **39** and provides protection from abrasion, in addition to being an electrical insulator.

[0035] The upper surface of substrate **31**, as the layers are arranged in FIG. **3**, is at least partially covered by conductive electrode **41**, which preferably is made by screen printing a conductive ink containing PEDOT/PSS (Poly-3,4-ethylene-