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(54) **SWITCH NOISE REDUCTION DEVICE AND METHOD USING COUNTER**

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(51) **Int. Cl.**
H03K 17/16 (2006.01)

(52) **U.S. Cl.** **327/384**; 327/385; 327/386; 341/24

(58) **Field of Classification Search** 327/384–386; 341/24
See application file for complete search history.

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Internet Document: Ganssle, Jack, "A Guide to Debouncing", The Ganssle Group (Aug. 2004) available at: http://www.ganssle.com/debouncing.pdf (accessed Nov. 7, 2006) Note the "counting algorithm" proposed in this document (starting on p. 18).

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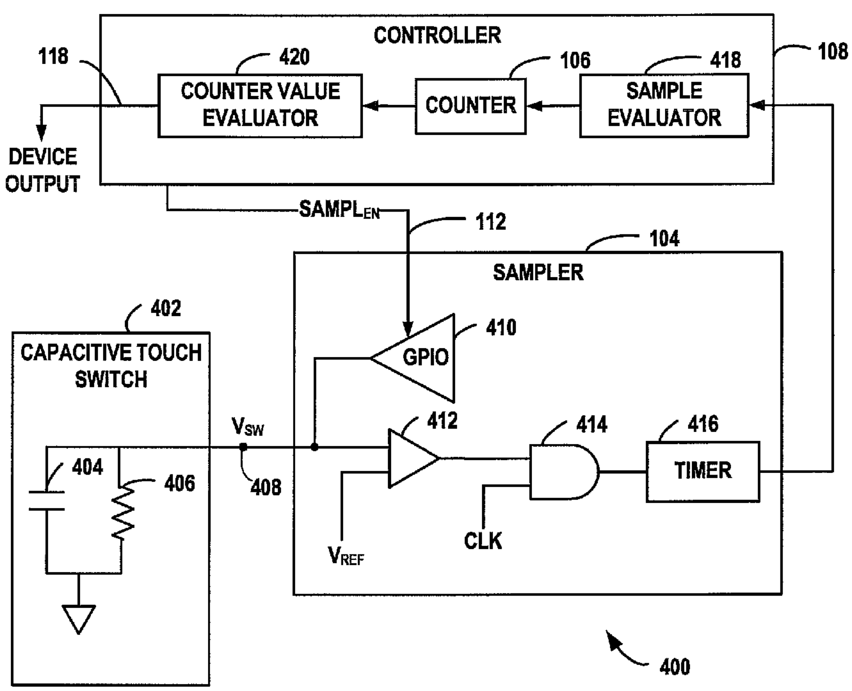
Primary Examiner—Kenneth B. Wells

(57) **ABSTRACT**

A switch de-bouncing device includes a majority counter that counts samples generated by a sampler sampling a switch output where a counter value is incremented for each sample indicating a first switch state and decremented for each sample indicating a second switch state of the switch. A controller determines that the switch is in the first switch state when the counter value is above a first state threshold and is in the second switch state when the counter value is below a second state threshold.

15 Claims, 4 Drawing Sheets



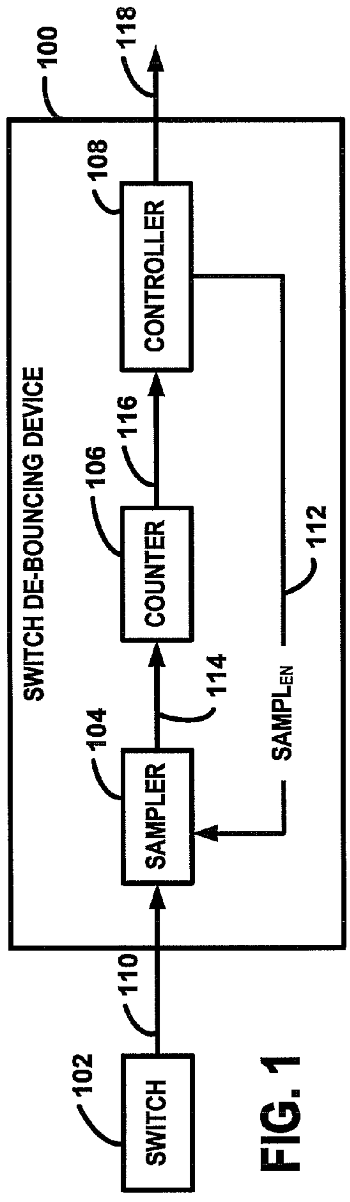

SWITCH DE-BOUNCING DEVICE
SWITCH
SAMPLER
COUNTER
CONTROLLER
SAMPL_EN
100
102
104
106
108
110
112
114
116
118

FIG. 1

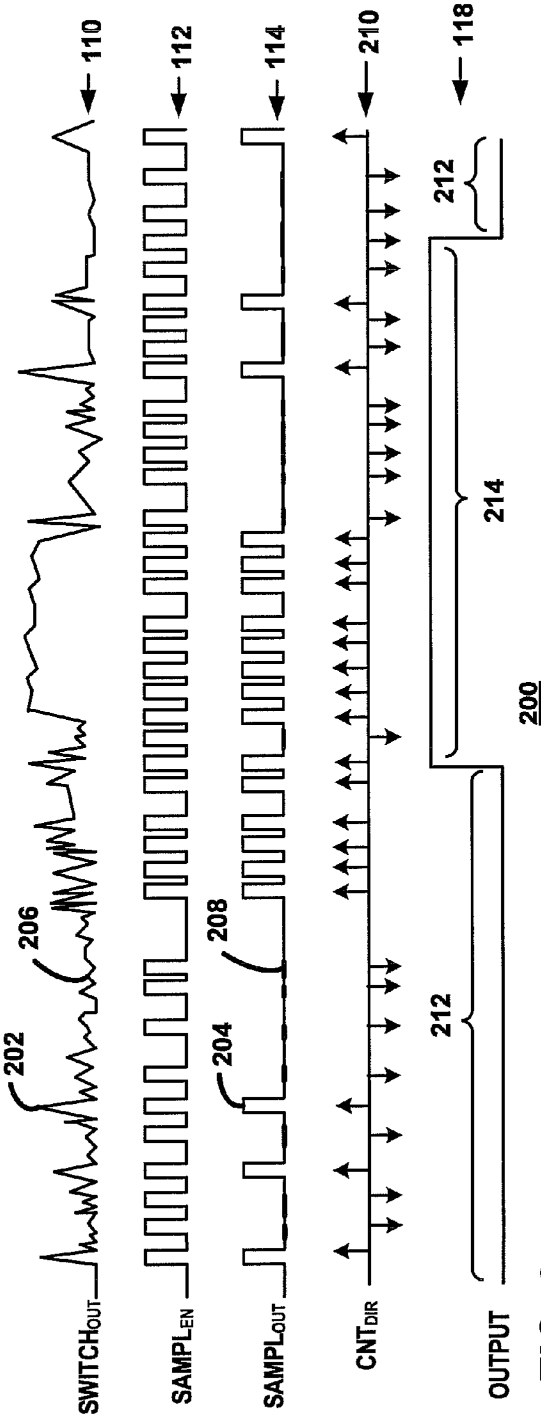

SWITCH_OUT
SAMPL_EN
SAMPL_OUT
CNT_DIR
OUTPUT
110
112
114
210
118
202
204
206
208
212
214
212
200

FIG. 2

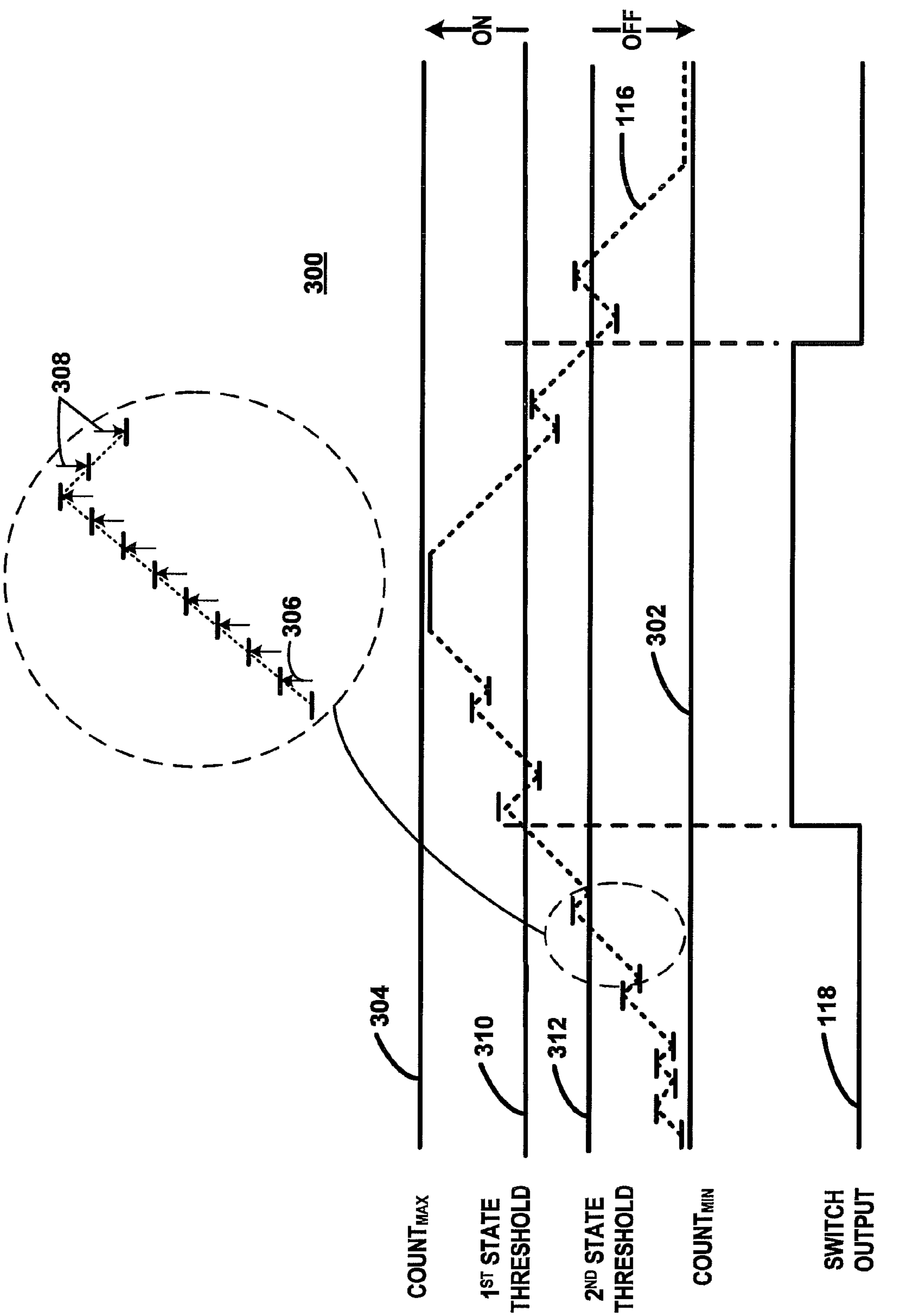

300
308
306
304
310
312
302
116
118
ON
OFF
COUNTMAX
1ST STATE THRESHOLD
2ND STATE THRESHOLD
COUNTMIN
SWITCH OUTPUT

FIG. 3

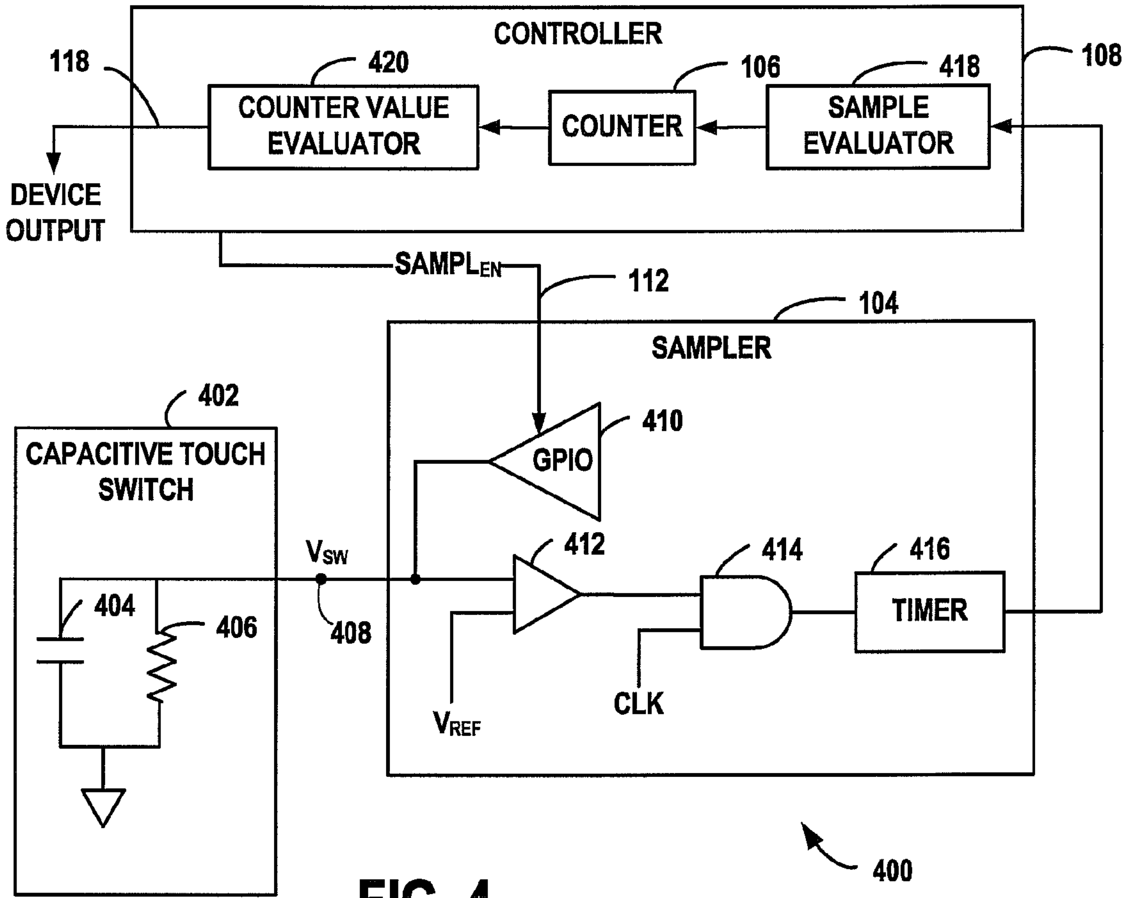

CONTROLLER
118
420
COUNTER VALUE EVALUATOR
106
COUNTER
418
SAMPLE EVALUATOR
108
DEVICE OUTPUT
SAMPLEN
112
104
SAMPLER
402
CAPACITIVE TOUCH SWITCH
410
GPIO
412
414
416
TIMER
VSW
404
406
408
VREF
CLK
400

FIG. 4

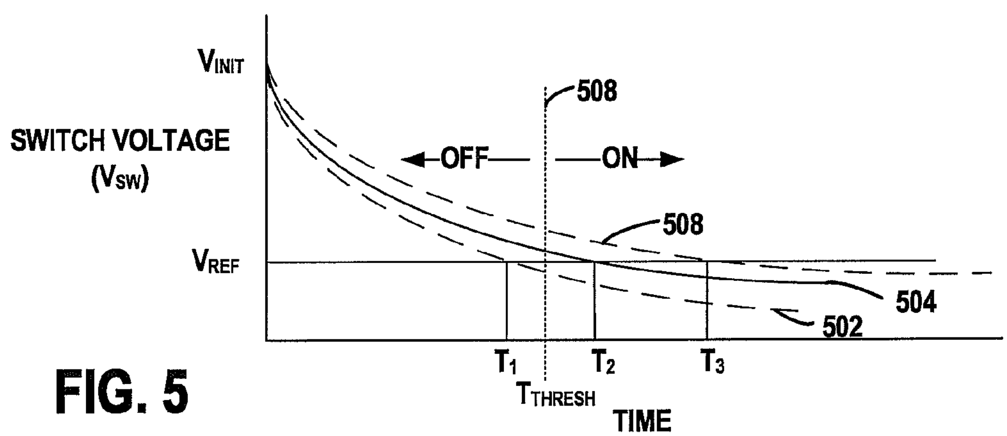

VINIT
508
SWITCH VOLTAGE (VSW)
OFF
ON
508
VREF
504
502
T1
T2
T3
TTHRESH
TIME

FIG. 5

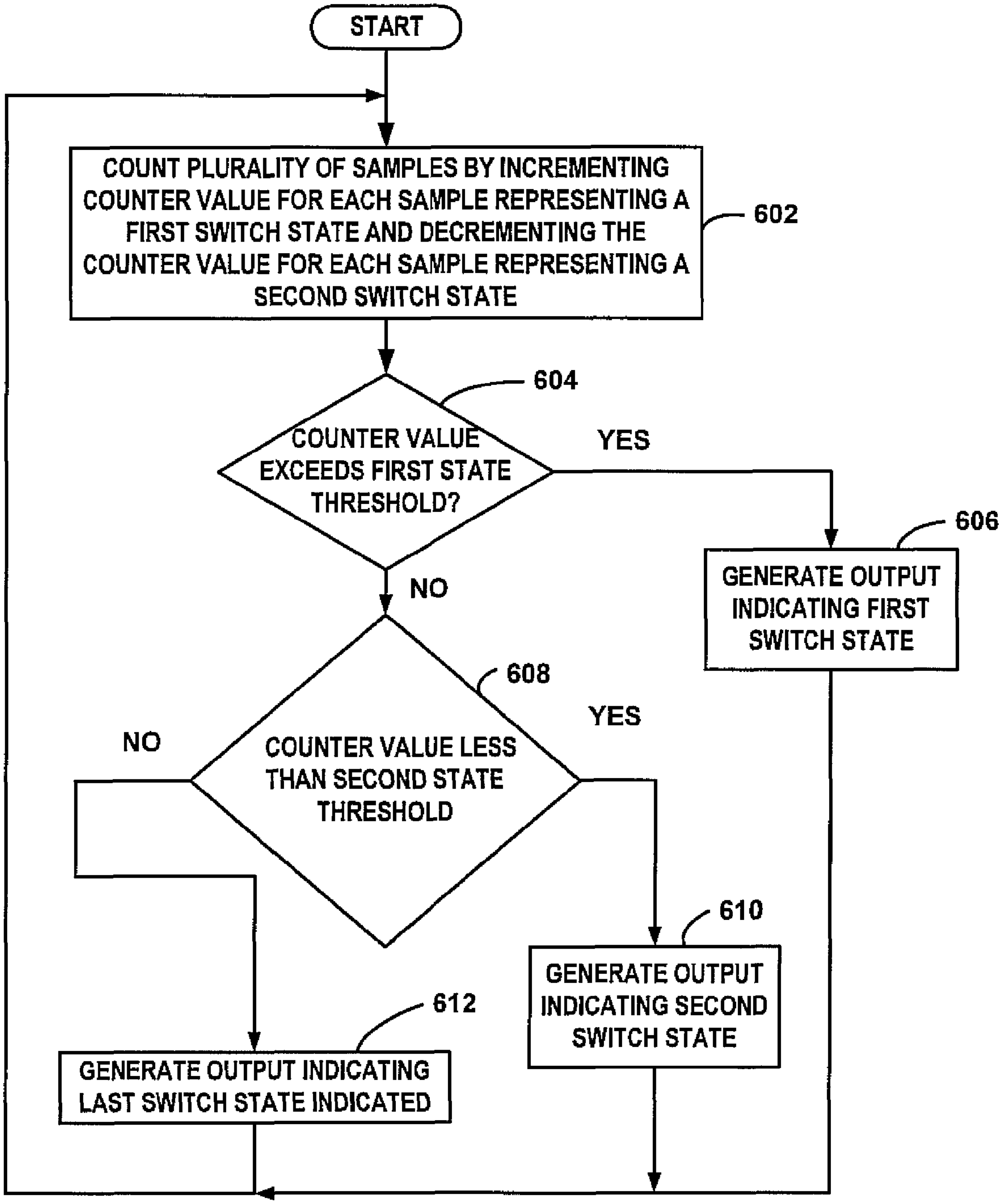

START
COUNT PLURALITY OF SAMPLES BY INCREMENTING COUNTER VALUE FOR EACH SAMPLE REPRESENTING A FIRST SWITCH STATE AND DECREMENTING THE COUNTER VALUE FOR EACH SAMPLE REPRESENTING A SECOND SWITCH STATE
602
604
COUNTER VALUE EXCEEDS FIRST STATE THRESHOLD?
YES
NO
606
GENERATE OUTPUT INDICATING FIRST SWITCH STATE
608
COUNTER VALUE LESS THAN SECOND STATE THRESHOLD
YES
NO
610
GENERATE OUTPUT INDICATING SECOND SWITCH STATE
612
GENERATE OUTPUT INDICATING LAST SWITCH STATE INDICATED

FIG. 6

SWITCH NOISE REDUCTION DEVICE AND METHOD USING COUNTER

FIELD OF THE INVENTION

This invention generally relates to switches and more particularly to a switch de-bouncing device and method.

BACKGROUND

Electrical switches are limited in that switch outputs are susceptible to false readings due to noise, bounce, or other causes. For example, contacts of mechanical switches may open and close as the contacts bounce after the switch is triggered from one state to another. The resulting switch output may be interpreted as multiple activations of the switch or may otherwise result in undesired readings. Other types of switches, such as capacitive touch switches, do not have mechanical moving contacts that bounce but are still susceptible to inaccurate outputs due to other causes such as noise. Electro-magnetic signals and static electricity, for example, may cause the charge in a capacitive touch switch to discharge more rapidly or more slowly than otherwise and may cause the sensing circuitry to incorrectly interpret the state of the switch. Conventional techniques for dealing with switch bounce and noise, however, are limited in that additional hardware components are required, adding size and expense. Further, fixed timing must be established and the information regarding the switch output must be tracked, increasing complexity and consuming resources. For example, many conventional techniques for addressing switch bounce and noise issues include obtaining multiple samples of the switch output at periodic intervals to verify that the switch output signal was stable and was not the result of a transient. Typically, such a software solution is paired with an external hardware element such as a resistor-capacitor (R/C) filter.

Therefore, there is a need for a switch de-bouncing device and method.

SUMMARY

A switch de-bouncing device includes a majority counter that counts samples generated by a sampler sampling a switch output where a counter value is incremented for each sample indicating a first switch state and decremented for each sample indicating a second switch state of the switch. A controller determines that the switch is in the first switch state when the counter value is above a first state threshold and is in the second switch state when the counter value is below a second state threshold.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram of switch de-bouncing device in accordance with an exemplary embodiment.

FIG. **2** is a graphical representation of exemplary signals received, processed and generated by the switch de-bouncing device.

FIG. **3** is a graphical representation of an exemplary counter value signal and a corresponding de-bouncing device output signal.

FIG. **4** is a block diagram of a switch system including a switch de-bouncing device connected to a capacitive touch switch where the switch de-bouncing device is a capacitive touch switch de-bouncing device.

FIG. **5** is a graphical illustration of exemplary relationships of the switch voltage over time for each sample period of the capacitive touch switch.

FIG. **6** is a flow chart of a method of de-bouncing a switch in accordance with the exemplary embodiment.

DETAILED DESCRIPTION

FIG. **1** is a block diagram of a switch de-bouncing device **100** connected to a switch **102**. The switch de-bouncing device **100** may be used to filter, process, or otherwise interpret the output of any of numerous switches **102** to reduce or eliminate false readings of the switch output due to noise, bounce, or other causes. The switch **102** may be a mechanical switch or other type of switch, such as a capacitive touch switch. The switch de-bouncing device **100** is designed in accordance with the type and size of switch as well as the anticipated causes for multiple and false readings. For example, the sampling rate for the switch de-bouncing device may be selected based on the frequency of the noise present at a capacitive touch switch. The switch de-bouncing device **100** may be implemented using any combination of hardware, software, and/or firmware to perform the functions described herein as implemented by a sampler **104**, a counter **106** and a controller **108**. Exemplary implementations of the sampler **104**, counter **106** and controller **108** are described below. The functions described as performed in a functional block may be performed by multiple devices or blocks. Further, functions described as performed in one block may be performed by other blocks in some circumstances. For example, the counter **106** may be implemented as part of a controller **108** in some situations.

The sampler **104** samples an output signal **110** received from an output of the switch **102** at a sampling rate determined by a sample enable signal ($SAMPL_{EN}$) **112**. The plurality of samples **114** generated by the sampler **104** are received by the counter **106** where each sample indicates the switch is in one of two switch states such as an on state and an off state. The counter **106** is a majority counter that increments a counter value for one of the states and decrements the counter for the other state. For an example discussed below, the counter value is incremented for each sample indicating an on switch state and decremented for each sample indicating an off switch state. In some situations, the counter value can be incremented for an off state sample and decremented for each on state sample. In such implementations, the thresholds and output signals are reversed as compared to the exemplary signals and values discussed herein. The counter value is not decremented below a minimum counter value or incremented above a maximum counter value.

The controller **108** generates an output signal **118** based on a counter value signal **116** received from the counter **106**. The controller **108** determines that the switch **102** is in the first switch state when the counter value has exceeded a first state threshold and determines that the switch **102** is in a second switch state when the counter value has declined below a second state threshold. For the example discussed, therefore, the controller **108** generates an output signal **118** indicating the switch is in the on state when the counter value exceeds an upper threshold and generates an output signal **118** indicating the switch **102** is in an off state when the counter value drops below a lower threshold.

FIG. **2** is a graphical representation of exemplary signals received, processed and generated by the switch de-bouncing device **100** where the first switch state is an on state and the second switch state is an off state. The switch output signal ($SWITCH_{OUT}$) **110** may have any combination of noise, bouncing, or other events that alter the intended state of the switch **102**. Accordingly, the switch output signals **110** shown in FIG. **2** generally represent outputs of mechanical switch and capacitive touch switches. In the exemplary embodiment, the sampler **104** samples the switch output **110** at sample times indicated by the controller **108** through the sample enable signal ($SAMPL_{EN}$) **112**. In some situations, the sampler **104** may sample without control from the controller **108**. For example, the sampler **104** may sample the signal at periodic intervals without direction from the controller **108**. The resulting sampler output signal **114** includes a plurality of samples where each sample indicates a state of the switch **102**. As shown in FIG. **2**, high switch output signals **202** interpreted as on states of the switch are represented as positive pulses **204**. Low switch output signals **206** interpreted as off states are represented as zero level signals **208**. Any of numerous techniques may be used to interpret the switch output **110** to determine a switch state at a sample time. A suitable technique includes generating an on state pulse **204** when the signal amplitude is above a threshold and generating an off state signal when the switch output signal amplitude is below the threshold.

A counter direction state (CNT_{DIR}) **210** shows the counter directions corresponding to the plurality of samples of the sampler output signal **114**. For each positive pulse of the sampler output signal **114**, FIG. **2** shows an upward pointing arrow indicating that the counter value **116** is incremented by one. For each zero sample, the counter direction state shows a downward pointing arrow indicating the counter value **116** is decremented by one. As mentioned above, the directions may be reversed in some implementations. As explained in further detail below with reference to FIG. **3**, the output **118** of the switch de-bouncing device **100** remains in an off state with a low level output **212** until the counter value exceeds the upper threshold (first state threshold) and remains in an on state with a high level output **214** until the counter value decreases below a lower threshold (second state threshold). Accordingly, the device **100** output follows a hysteresis function.

FIG. **3** is a graphical representation **300** of an exemplary counter value signal **116** and a corresponding de-bouncing device output signal **118**. The values depicted in FIG. **3** do not necessarily correspond to the values represented in FIG. **2**. As discussed above, the counter value is incremented and decremented based on the samples generated by the sampler **104**. The counter value **116** is increased for each sample indicating a first switch state and decremented for each sample indicating a second switch state. In the exemplary embodiment, the counter value **116** is incremented by one increment **306** for each sample indicating the switch is in an on state and decremented by one decrement **308** for each sample indicating the switch is in the off state. The counter value **116** ranges from a minimum counter value ($COUNT_{MIN}$) **302** to a maximum counter value ($COUNT_{MAX}$) **304**. Accordingly, the counter value is not decreased below the minimum counter value **302** or increased above the maximum counter value **304**. When the counter value exceeds a first state threshold **310**, the controller **108** determines that the switch **102** is in the first switch state and generates an output **118** indicating the first switch state. In the exemplary embodiment, the first state threshold **310** is an on state threshold and the controller **108** generates a high level output **214** indicating the switch is on. When the counter value **116** decreased to the second switch state **312**, the controller **108** generates an output **118** indicating the switch **102** is in the second switch state. In the exemplary embodiment, the second state threshold **312** is an off state threshold and the controller **108** generates a low level output **212** indicating the switch is off. Therefore, the output signal **118** of the de-bouncing device **100** follows a hysteresis function. Noise, bouncing, and other potential causes of false readings have minimal or no impact on the interpreted switch output. The exemplary de-bouncing device **100** using the majority counter is less likely to generate a false reading than a conventional de-bouncing circuit based on a counter value average since large extraneous signals do not affect the majority counter value as much as an average counter value. Although the de-bouncing device **100** may be used with various types of switches, the exemplary de-bouncing device **100** is especially useful with capacitive touch switches.

FIG. **4** is a block diagram a switch system including a switch de-bouncing device **100** connected to a capacitive touch switch **402** where the switch de-bouncing device **100** is a capacitive touch switch de-bouncing device **400**. The capacitive touch switch **402** includes two adjacent conductive areas on an insulating material such as glass or a printed-circuit board to form a capacitor **404**. The conductive layers create a capacitance that increases when the areas are bridged such as when a finger is placed over them. The state of the switch **402** is determined by determining the change in capacitance from before and after the areas have been bridged. In the exemplary embodiment, a resistor **406** and the capacitor **404** form an RC circuit having a time constant that is determined by measuring the decay period of a switch voltage (V_{SW}) **408** across the RC combination. A general purpose input/output (GPIO) port **410**, in response to the sample enable signal ($SAMPL_{EN}$) **112** provided by the controller **108**, applies a voltage to the RC circuit then presents a high impedance to the circuit. Therefore, an initial voltage is applied to the switch **402** for a duration sufficient to charge the capacitor **404** before the GPIO port **410** is turned off to present a high impedance to allow the capacitor **404** to discharge through the resistor **406**. A comparator **412** generates a logic signal based on the voltage across the switch **402** and a reference voltage. When the switch voltage **408** is greater than the reference voltage, the comparator **412** generates a high logic signal. Otherwise the output signal from the comparator **412** is a low logic signal. A clock signal and the output of the comparator **412** are received at an AND gate **414**. As a result the output of the AND gate **414** is a series of clock pulses that begin when the GPIO port **410** is set high until the voltage (V_{SW}) **408** across the capacitance **404** decays through the resistance **406** below the reference voltage (V_{REF}). A timer **416** is reset at each sample and measures the duration of the decay by the number of clock cycles that elapse. The controller **108** determines if the time period indicates that the switch **402** has been touched. If the time period is longer than a threshold period, the controller **108** determines that the switch **402** is providing an output that indicates that the switch **402** has been touched. If the time period is less than a threshold, the controller **108** determines that the switch output **110** indicates that switch **410** has not been touched. The indications by the switch output **110**, however, may not accurately indicate the actual state of the switch **402**. Noise may alter the voltage (V_{SW}) **408** across the capacitor **404** resulting in a shorter or longer voltage decay period than would have occurred without the noise. In some cases the noise sufficiently alters the voltage (V_{SW}) **408** to cause the time period to indicate the opposite state of the switch from the state that would have been indicated without the presence of noise.

In accordance with the exemplary embodiment, the controller **108** monitors the counter value to determine the state of the switch **402**. As described above, the counter **106** counts the samples by incrementing and decrementing the counter value based on the states indicated by each sample. Each sample is evaluated to determine the direction of the counter, the counter is incremented or decremented and the counter value is evaluated to determine the appropriate output **118**.

A sample evaluator **418** processes the data captured by the timer to determine if each sample represents a first switch state or a second switch state. The sample evaluator **418** determines if the decay time period measured by the timer for a sample is greater than or less than a sample threshold. If the sample decay time period is greater than the sample threshold, the sample evaluator **418** determines the sample represents a first state sample such as on state sample. If the sample period is less than or equal to the sample threshold, the sample evaluator determines the sample indicates a second state sample such as an off state sample. The sample evaluator is implemented as part of the controller **108** in the exemplary embodiment.

Based on the determinations of the sample evaluator **418**, the counter **106** is incremented or decremented. A counter value evaluator **420** evaluates the counter value to determine the output **118**.

The various components of the switch de-bouncing device **400** may be implemented using any combination of hardware, software and/or firmware. One or more functional blocks discussed with reference to FIG. **4** may be implemented over several devices or within a single device. For example, counter **106**, sample, evaluator. Counter evaluator **420** and any number of sampler components may be implemented in a signal processor or application specific integrated circuit (ASIC). An example of suitable implementation includes utilizing a single micro-processor that contains hardware implementations of an oscillator, GRID controller, comparator, gating logic, timer and memory. Firmware code contained in one part of the memory, such as a ROM, controls the various hardware devices to generate samples from the timer that are counted. The count is stored in another part of the memory, such as RAM. The firmware processes and invokes actions based on the resulting count based on pre-determined thresholds or may communicate the result to another external device. Selections of the particular component values and device types are based on the size of the switch and characteristics of the expected noise. An example of a typical capacitive touch switch **402** for use in a portable communication device includes a capacitance on the order of 10 to 200 pF and a resistance of 4.7 MΩ. For such a switch **402**, a suitable timer includes a 16 bit timer where the clock frequency is about 8 MHz. Suitable values for the minimum counter value **302** and the maximum counter value **304** are 0 and 31, respectively. A suitable first state threshold (upper threshold) **310** is 25 and a suitable second state threshold (lower threshold) **312** is 6.

FIG. **5** is a graphical illustration of exemplary relationships of the switch voltage over time for each sample period of the capacitive touch switch **402**. The curves **502**, **504**, **506** of the switch voltage **408** over time show general relationships between the voltage **408** and time for different situations and are not necessarily to scale. The most quickly decaying curve **502** reaches the reference voltage (V_{REF}) within a decay period of T_1. The slowest decaying curve **506** reaches the reference voltage (V_{REF}) within a decay period of T_3. The middle curve **504** reaches the reference voltage (V_{REF}) within a decay period of T_2 which is between the two other periods. In the exemplary embodiment, the sample evaluator **418** compares the decay period for each sample and determines if it is greater than a sample threshold (T_{THRESH}) **508**. If the sample period is greater than the sample threshold, the sample evaluator **418** determines that the sample is an on state sample. If the sample period is less than or equal to the sample threshold, the sample evaluator **418** determines that the sample is an off state sample. Accordingly, for the example in FIG. **5**, the most quickly decaying curve **502** would be timed by the timer **416** and determined to be an off state sample. The other curves with sample periods of T2 and T3 are determined to be on state samples. As described above, the counter **106** value is incremented and decremented based on the resulting sample states.

FIG. **6** is a flow chart of a method of de-bouncing a switch in accordance with the exemplary embodiment. Although the method can be executed by any combination of hardware, software and/or firmware, the method is performed by executing software code on the controller **108** in the exemplary embodiment.

At step **602**, a plurality of samples are counted by incrementing a counter value **116** for each sample representing a first switch state and decrementing the counter value **116** for each sample representing a second switch state. Samples generated by a sampler are evaluated to determine the state of the switch indicated by each sample. If the sample indicates a first state such as an on state, the counter value **116** is incremented. If the sample indicates a second switch state, such as an off state, the counter value **116** is decremented. The counter value **116** is maintained between a minimum counter value **302** and a maximum counter value **304**. Accordingly, the counter value **116** is not incremented if the counter value **116** is equal to the maximum counter value **304** and is not decremented if the counter value **116** is equal to the minimum counter value **302**.

At step **604**, it is determined whether the counter value **116** exceeds the first state threshold **310**. If the counter value **116** is greater than the first state threshold **310**, the method continues at step **606**. Otherwise, the method proceeds to step **608**.

At step **606**, a device output signal **118** is generated that indicates the state of the switch **402** is the first switch state. Therefore, if the first switch state is an on state and the counter value **116** is determined to be greater than the on state threshold (first state threshold) in step **604**, the switch de-bouncing device **100** generates an output signal **118** indicating the switch **402** has been activated and is in the on state. The output signal **118** is maintained until the method requires a change. Accordingly, the method returns to step **602** to continue counting the samples.

At step **608**, it is determined whether the counter value **116** is less than a second state threshold **312**. If the value is below the second state threshold **312**, the method continues at step **610**. Otherwise, the method proceeds to step **212**.

At step **610**, a device output signal **118** is generated that indicates the state of the switch **402** is the second switch state. Therefore, if the second switch state is an off state and the counter value **116** is determined to be less than the off state threshold (second state threshold **312**) in step **608**, the switch de-bouncing device **100** generates an output signal **118** indicating the switch **402** has not been activated and is in the off state. The output signal **118** is maintained until the method requires a change. Accordingly, the method returns to step **602** to continue counting the samples.

At step **612**, the device output signal **118** is generated that indicates the previous state of the switch **402**. The method arrives at step **612** when the counter value **116** is not greater than first state threshold **310** and is not less than the second state threshold **312**. Accordingly, the counter value **116** is between the two thresholds **310**, **312** at step **612**. The output signal is not changed from the immediately previous state indicated and the method returns to step **602** to continue counting samples.

Any of numerous software code steps may be executed to perform the steps described of the exemplary method. An example of code suitable to perform the method is provided immediately below. For the following example, the minimum counter value **302** is equal to 0 and the maximum counter value **304** is equal to 31. The first state threshold is 25 and the second state threshold is 6. The previously described device and method may be applied to any signal susceptible to noise. For the exemplary code below, an AC signal is sampled to determine the polarity for the purpose of generating a line frequency clock source while eliminating false levels that a simple comparator would generate due to noise on the line. "Debouncer" is a variable for counting high (count up) or low (count down) states of the sampled AC signal. "Sine_level_was" is a previous state of the AC signal as determined from the Debouncer count. "Sine_level_is" is the current state of the AC signal as determined from the Debouncer count. "Sine_counter" is a simple count of changes between low and high levels of Sine_level_was and Sine_level_is. The numbers 0, 6, 25 and 31 are set as examples of the minimum, second threshold, first threshold and maximum values of Debouncer, respectively.

Following the execution of the code below, if the sampled AC signal is determined to be high and the Debouncer has not yet reached its maximum value of 31, Debouncer is incremented. If the sampled AC signal is determined to be low and the Debouncer has not yet reached its minimum value of 0, Debouncer is decremented. If Debouncer is less than the second threshold of 6, the AC line is considered to be currently low, i.e. Sine_level_is low (or alternatively 0). If Debouncer is greater than the first threshold of 25, the AC line is considered to be currently high, i.e. Sine_level_is is high (or alternatively 1). If Sine_level_is different than Sine_level_was, i.e. a change of state, the Sine_counter variable is incremented and Sine_level_was is made equal to Sine_level_is in preparation for the next change of state. A modulo-60 counter is implemented for the purpose of converting a 60 Hz line frequency to seconds.

```
unsigned int1 quarter_second(void){
static unsigned int8 debouncer;
static unsigned int1 sine_level_was
static unsigned int8 sine_counter;
static unsigned int1 sine_level_is;
if (line_clock)
{
//count up if line sensed high
if(debouncer<31)
        debouncer++;
}
else
{
//count down if line sensed low
if (debouncer>0)
   debouncer−−;
}
//if less than 1 to 0 hysterisis then its now low, otherwise no change
if (debouncer<6)
sine_level_is=0;
//if greater than 0 to 1 hysterisis then its now high, otherwise no change
if (debouncer>(31−6))
sine_level_is=1;
//if current state is different than old state, then act on change
if (sine_level_is != sine_level_was)
{
sine_level_was=sine_level_is;   //old state is current state
sine_counter++;
if (sine_counter==60)
   {
        sine_counter=0;
```


-continued

```
        return 1;
    }
  }
return 0;
```

Accordingly, the exemplary switch de-bouncing device **100** and method minimizes false readings of a switch **102** by maintaining a count of samples where the counter value **116** is incremented for samples indicating a first switch state and decremented for samples indicating a second switch state where a first state threshold **310** is greater than the second state threshold **312**. The two thresholds **310**, **312** establish a hysteresis threshold range. Sampling may occur at any frequency which may be considered to be asynchronous to the expected noise source and at a rate such that the count to the upper and lower thresholds occurs faster than the expected response time of the input. Processing resources are efficiently utilized since sampling is not required to be periodic and processing tasks can be executed for sampling when the burden on resources is minimized. No fixed timing must be established between correlated readings and no information about the input beyond the majority counter value needs to be retained from one input sampling to the next. Hysteresis and response may be dynamically programmed by selection of the maximum counter value **304**, the first state threshold and the second state threshold. External filtering is not required. Hard logic Schmidt trigger inputs with arbitrary thresholds are not needed to deal with slow edge rate signals.

Clearly, other embodiments and modifications of this invention will occur readily to those of ordinary skill in the art in view of these teachings. The above description is illustrative and not restrictive. This invention is to be limited only by the following claims, which include all such embodiments and modifications when viewed in conjunction with the above specification and accompanying drawings. The scope of the invention should, therefore, be determined not with reference to the above description, but instead should be determined with reference to the appended claims along with their full scope of equivalents.

What is claimed is:

1. A switch noise reduction device comprising:

a counter configured to count, at a constant rate, a plurality of samples of a switch output by incrementing a counter value by a count value for each sample representing a first switch state and decrementing the counter value by the count value for each sample representing a second switch state;

a controller configured to determine the switch is in the first switch state when the counter value exceeds a first state threshold and to determine the switch is in the second switch state when the counter value is below a second state threshold; and

a sampler configured to sample, at a sampling frequency different than a noise frequency of noise, the output of the switch to generate the plurality of samples, the sampler comprising a timer configured to determine a voltage decay period for each sample of the plurality of samples, the voltage decay period corresponding to a time required for a switch voltage of a capacitive touch switch to discharge from an initial voltage to a reference voltage.

2. The switch noise reduction device of claim **1**, wherein the controller is configured to determine the switch is in a previous switch state when the counter value is less than the first state threshold and above the second state threshold.

3. The switch noise reduction device of claim **2**, wherein the first state is an on state and the second state is an off state.

4. The switch noise reduction device of claim **1**, wherein the sampler further comprises a general purpose input/output (GPIO) port configured to charge a capacitance of the capacitive touch switch to the initial voltage and to allow a charge of the capacitance to discharge through a resistance in parallel with the capacitance to generate each sample.

5. The switch noise reduction device of claim **1**, further comprising a sample evaluator configured to generate an on state sample for each voltage decay period greater than or equal to a sample threshold and to generate an off state sample for each voltage decay period less than the sample threshold.

6. The switch noise reduction device of claim **1**, wherein the first state threshold is greater than the second state threshold.

7. A method for reducing susceptibility of noise in a switch, the method comprising:

counting, a constant rate, a plurality of switch samples of a switch output by incrementing a counter value by a count value for each sample representing a first switch state and decrementing the counter value by the count value for each sample representing a second switch state;

determining the switch is in the first switch state when the counter value exceeds a first state threshold and the switch is in the second switch state when the counter value is below a second state threshold; and

measuring a voltage decay period for each sample of the plurality of samples, the voltage decay period corresponding to a time required for a switch voltage of a capacitive touch switch to discharge from an initial voltage to a reference voltage.

8. The method of claim **7**, further comprising:

sampling, at a sampling frequency different than a noise frequency of the noise, the output of the switch to generate the plurality of samples.

9. The method of claim **7**, further comprising:

determining the switch is in a previous switch state when the counter value is less than the first state threshold and above the second state threshold.

10. The method of claim **9**, wherein the first state is an on state and the second state is an off state.

11. The method of claim **7**, further comprising:

charging a capacitance of the capacitive touch switch to the initial voltage with a general purpose input/output (GPIO) port; and

allowing a charge of the capacitance to discharge through a resistance in parallel with the capacitance to generate each sample.

12. The method of claim **11**, further comprising:

generating an on state sample for each voltage decay period greater than or equal to a sample threshold; and

generating an off state sample for each voltage decay period less than the sample threshold.

13. A switch device comprising:

a sampler configured to sample an output of a capacitive touch switch to generate a plurality of samples, each sample indicating one of two switch states comprising an on state and an off state, the sampler comprising a timer configured to determine a voltage decay period for each sample of the plurality of samples, the voltage decay period corresponding to a time required for a switch voltage of the capacitive touch switch to discharge from an initial voltage to a reference voltage;

a counter configured to count, at a constant rate, the plurality of samples by incrementing a counter value, by a count value, for each sample representing the on state and decrementing the counter value by the count value for each sample representing the off state; and

a controller configured to determine the switch is on when the counter value exceeds an on state threshold and to determine the switch is off when the when the counter value is below an off state threshold, the on state threshold greater than the off state threshold.

14. The switch device of claim **13**, wherein the controller is configured to determine the switch is in a previous switch state when the counter value is less than the on state threshold and above the off state threshold.

15. The switch device of claim **13**, wherein the sampler is configured to sample the output at a sampling frequency different than a noise frequency.

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