Observing & Measuring Contact Bounce Of A Mechanical Switch, or, Why De-bouncing Circuits Are Needed

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Purpose:

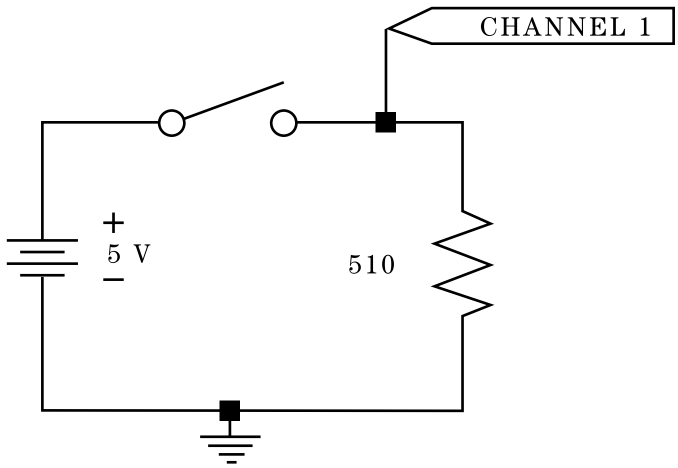
Electrical switches which use mechanical contacts to close and open a circuit are subject to a bouncing of the contacts. The average user of a flashlight is blissfully unaware that the current actually gets turned on and off dozens of times each time the flashlight is turned on or off, since the human eye (and the tungsten filament of the bulb) cannot respond to the short duration interruptions of current. However, this phenomenon is well known to circuit designers who work with push buttons, keyboards, toggle or slide switches by the havoc that can be caused by ***not*** dealing with it. While the results of contact bounce are apparent, and the circuitry or software solutions are generally known, many people have not actually seen the electrical signature of a particular switch's bouncing. The single-shot display capability of the HP 54601B digitizing oscilloscope allows us easily to record and measure the bouncing of a switch.

Equipment Required:

- HP 54600 - Series Oscilloscope

Circuit Explanation:

The circuit below is that of a flashlight, with the resistor representing the bulb. By putting the oscilloscope in single-shot mode, and by triggering on the rise of voltage at the top of the resistor, the entire sequence of contact bounces can be seen.



Procedure A - Determining Contact Bounce During Switch Closure:

1) Return the oscilloscope to its default settings by pressing the SETUP hardkey, and then the DEFAULT SETUP softkey. Put the switch into the **open** position.

2) Connect channel 1 to the top of the resistor using a 10X probe. ***Be sure to make the probe setting correct (10X) by using the PROBE softkey for channel 1 (press 1 to select channel 1, and then press the PROBE softkey as needed to toggle between a divide by 1 or 10 or 100 probe).***

3) Set the **Volts/Div** control for channel 1 to 1 V/Div. Press the trigger **mode** hardkey, and then the **normal** trigger mode softkey. Set the trigger **level** control for something more than 0 V and less than 5 V (e.g. 1 V). The trigger slope is positive (this is the default slope).

4) Flip the switch from off to on repeatedly. Each time the switch is moved, the sweep of the oscilloscope should be triggered and a new trace recorded (*you may want to think about why switching to off, even though the trigger slope is positive, causes triggering to occur*). If more than one trigger occurs for a single movement of the switch, choose the trigger **mode** hardkey, and then the **single** trigger mode softkey. You will have to press the **Run** hardkey after each trigger to "arm" the sweep.

5) Adjust the **Time/Div** control on the front panel for a display that shows the initial switch from 0 V to 5 V, and all of the bounces, until steady state (constant 5 V) is reached (see Figure 1 for a typical display).

6) Press the **Stop** hardkey, and then press the **Display** hardkey followed by the **Vectors On** softkey. Notice that Vectors On essentially "connects the dots", allowing transitions between the two voltage levels to be seen more clearly.

7) Measure the time required for switch bounce to end, and the approximate number of bounces, for a gentle movement of the switch from OFF to ON. Repeat for a rather vigorous "flick" of the switch.

Measurement of Switch Bounce, Going from OFF to ON

Type of Bounce	Bounce Time	Approx. # of Bounces
Gentle		
Vigorous "Flick"		

Procedure B - Determining Contact Bounce During Switch Opening:

1)Keep everything as it was in procedure A, except change the trigger slope to **negative**.

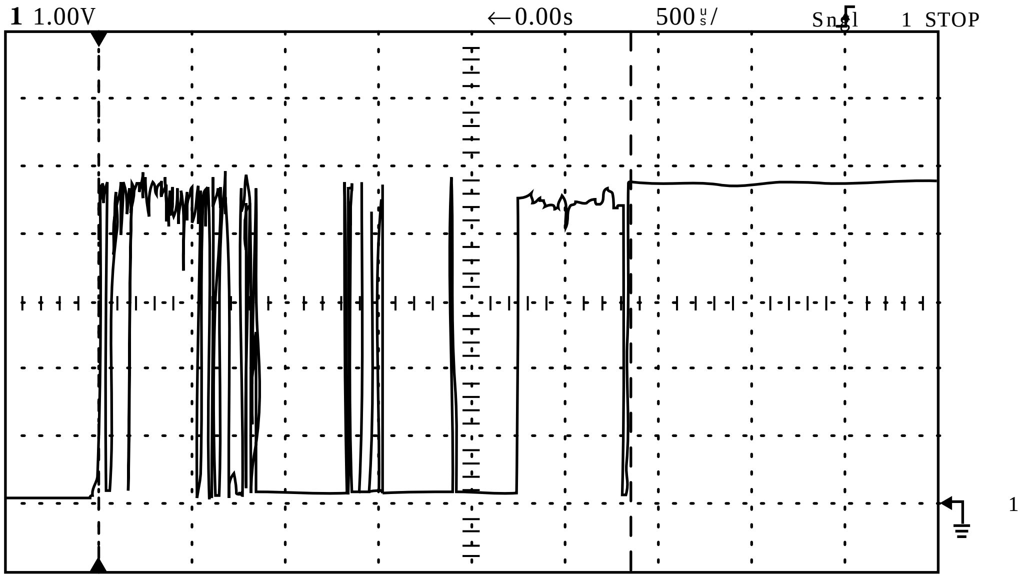
2) Measure the time required for switch bounce to end, and the approximate number of bounces, for a gentle movement of the switch from ON to OFF. Repeat for a rather vigorous "flick" of the switch.

Measurement of Switch Bounce, Going from ON to OFF

Type of Bounce	Bounce Time	Approx. # of Bounces
Gentle		
Vigorous "Flick"		

If time permits, try using the other switch on your op-amp designer board. Though it is an "identical" switch, its bounce performance is likely to be quite different (see Figure 2).

Try a different kind of switch (toggle, or push-button) to see what its bounciness is.



t1 = 0.000 s   t2 = 2.870ms   Δt = 2.870ms   1/Δt = 348.4 Hz

	State	Volts/Div	Position	Couplg	BW Lim	Invert	Probe
Chan 1	On	1.000 V	-3.000 V	DC	Off	Off	10:1
Chan 2	Off	5.000 V	0.000 V	DC	Off	Off	10:1
Chan 3	Off	100.0mV	0.000 V	DC	---	---	1:1
Chan 4	Off	100.0mV	0.000 V	DC	---	---	1:1

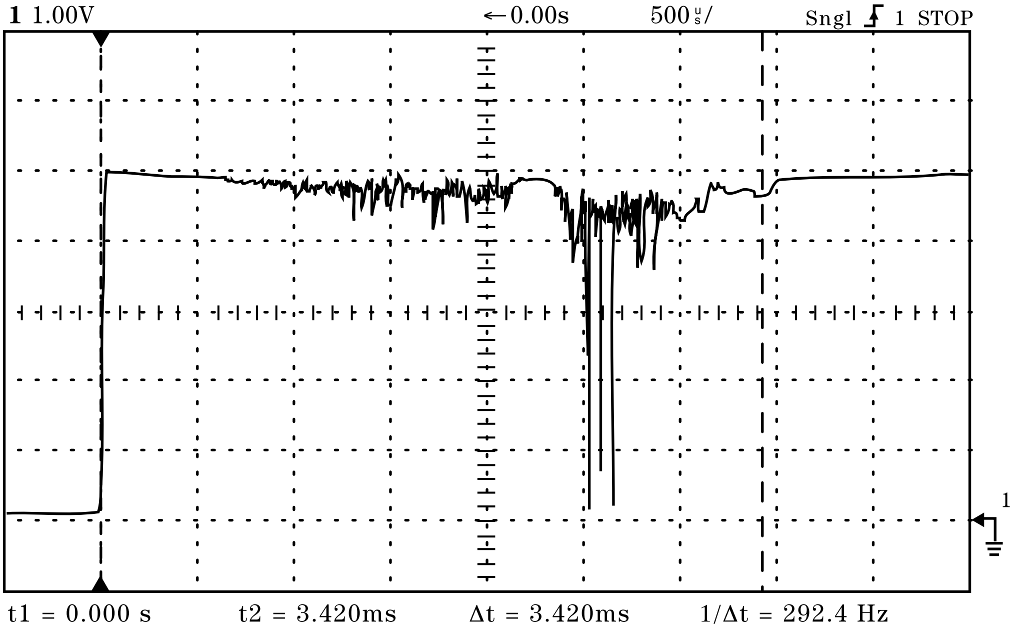
	Mode	Main Time/Div	Main Delay	Time Ref	Delayed Time/Div	Delayed Delay
Horizontal	Normal	500.0us/	0.000 s	Left	-------------	-------------

Trigger	Mode	Source	Level	Holdoff	Slope	Couplg	Reject	NoiseRej
	Single	Ch 1	2.656 V	200.0ns	Pos	DC	Off	Off

Display Mode: Normal

Cursors: t1= 0.000ms t2=2.870ms V1(1)=562.5mV V2(1)=5.000 V

Figure 1 - Switch Bounce Going From OFF to ON



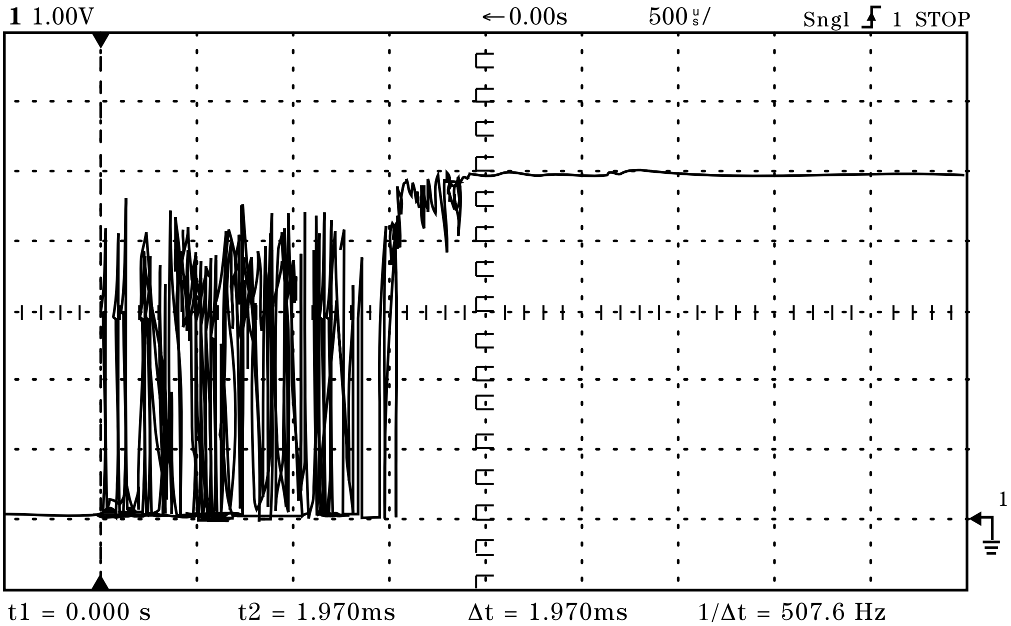


Figure 2 - Switch Bounce for Two"Identical" Switches