R8C/38T-A Group

Using Springs with Touch MCUs

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Introduction

The following document describes the use of springs to interface to the front panel of a touch system utilizing touch buttons. The sensitivity of the touch system is described when using different spring shapes.

Target Device

R8C/33T, R8C/3JT, R8C/3NT, R8C/36T-A and R8C/38T-A

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1. Introduction

The optimum interface for capacitive touch is a sensor mounted directly to the interface panel with the sensing MCU on the same board and a short distance away. In many actual applications it is not easy or cost-effective to have the sensor and MCU board mounted to the interface panel. A convenient transition when the PC board cannot be in direct contact with the front panel is a spring. The spring allows an electrical contact between the sensing PC board and the front panel. The spring can compensate for small variations in the distance between the sensing board and the front panel which may include curved surfaces

When a spring is utilized the touch interface still occurs at the panel. The spring becomes an extension of the PC board trace except for the portion which is pressed against the panel. The effective area of this interface will impact the sensitivity of the system to a touch in the same way changing the diameter of a sensor pad on the PC board will affect the sensitivity, a smaller area generally implies reduced sensitivity.

2. Touch Sensitivity with Springs

Testing was performed to provide a relationship between various spring sizes and configurations and the touch sensitivity. The majority of the testing was performed on the WW Kit board (part #). Testing was performed on the star key (*) since this key is one of the furthest from the MCU and since it was closer to the edge of the board it would be most appropriate for noise pickup tests. Testing was performed on other board configurations and using R8C/33T instead of the R8C/36T and all data was found to correlate so only the WW Kit data is described.

2.1 Springs Tested

Five spring configurations were evaluated during the test. Four springs were typical helical spring configurations with the fifth spring being a leaf spring implementation. In addition to modifying the spring size springs were tested with and without an increased sensor surface area at the panel interface which was created using a 12mm square of copper foil tape. Attaching the tape to the front panel or the top of the spring provided the same results.

The characteristics of the four helical springs is described in Table 1 and shown in Figure 1:

	Spring Style	Diameter	# turns	Free Length	Wire Dia	Comment
Spring 1	Cylindrical	4 mm	11	19 mm	0.25 mm	
Spring 2	Cylindrical	6 mm *	7	12 mm	0.5 mm	*12 mm cap
Spring 3	Conical	12 mm	5	12 mm	0.75 mm	
Spring 4	Conical	15 mm	5	23 mm	0.625 mm	

Table 1

Figure 1

A leaf spring was formed to a 12 mm height by bending 0.12 mm X 3 mm flat stainless spring steel into an arc as shown in Figure 2. The leaf spring configuration is considered since shaping of the spring in contact with the panel interface could provide improved slider performance.

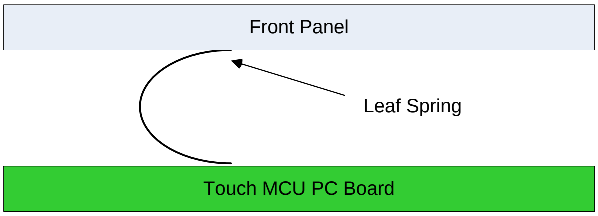

Figure 2

Variations on this leaf included using two “fingers” and connecting the two fingers at the panel interface with a crossing piece of spring, which should be simple to manufacture using a stamped manufacturing method. The connected fingers design had a hole punched which could allow LED lighting through to the panel. The design is shown schematically in Figure 3

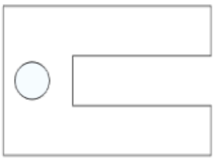

Figure 3

2.2 Sensitivity Results

The results of the sensitivity testing of the springs are shown in Table 2 below. This data is taken using Workbench which is after the 4 tap FIR filter implemented in the SCU driver code so the values are approximately 4 times the reading that would be obtained from the SCU data buffers. During the testing the front panel to PC board height was adjusted so the springs were compressed to approximately 20% of their free length.

Spring Configuration	Non-Touched Counts	Delta Counts
Direct Panel Interface (15 mm pad)	500	280
Spring 1	549	40
Spring 1 with Foil Interface	430	140
Spring 2	520	150
Spring 3	492	118
Spring 4	440	120
Spring 4 with Foil Interface	424	184
Single Finger Leaf	450	80
Two Finger Leaf	500	92
Two Finger Connected Leaf	492	104

Table 2

3. Noise Influences

In real applications external noise effects must also be considered. To investigate the performance of the various spring configurations in the presence of a noise source an induction heating unit was used. Figure 4 shows the arrangement used to test. The "star" key is closest to the induction unit. The testing arrangement was utilized to keep the noise pickup in a range which did not swamp any of the configurations and to minimize the shielding influence of the ground fill on the PC board.

Figure 4

The influence of the noise on the configuration was performed by first touching the button with no noise, the induction unit was then powered on to level 4 and a second touch was performed. Workbench was used to capture the waveforms. Figure 5 shows the response of the system with the overlay mounted directly to the touch PC board, which is the default configuration of the WW kit board. The "star" key is channel 10, notice on the left side of the trace there is very little noise. The next event is a touch with no noise, then the noise source is turned on. Though some influence from the noise is visible the signal-to-noise ratio (SNR) still stays very high and the touch is very easily distinguished.

Figure 5

The next figure shows the same test using spring 4 (largest diameter). Notice there is more noise influence but the touch is still a distinct event

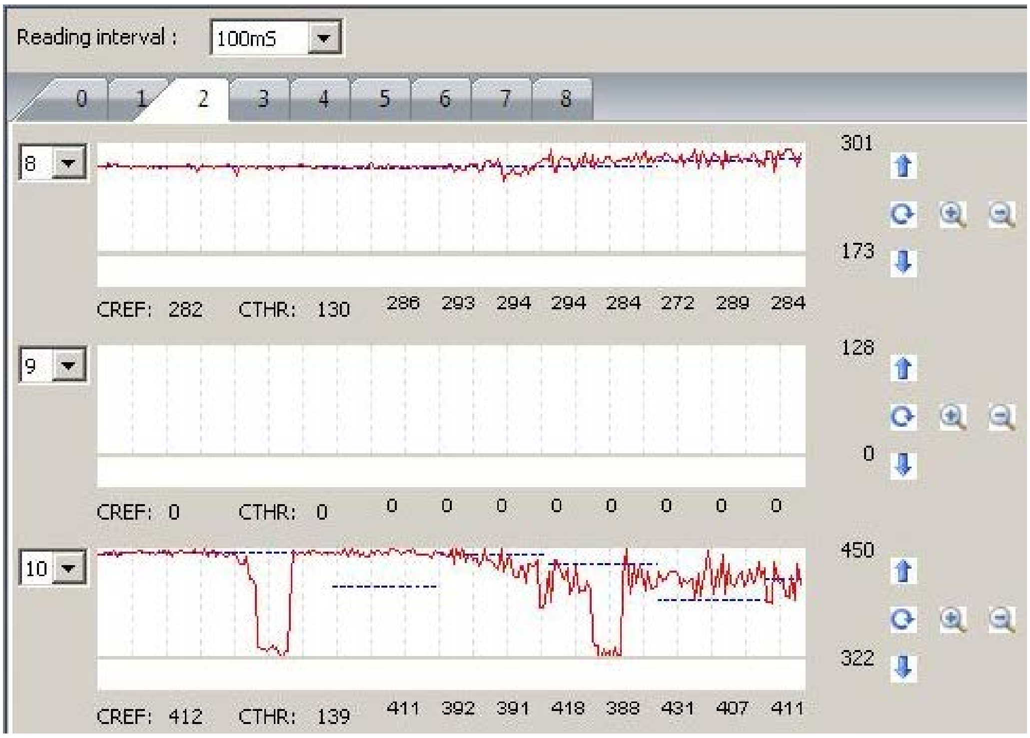

Figure 6

Spring 3, the diameter spring is shown in Figure 7. Notice the sensitivity is very close to the previous spring but the noise influence appears to be much less, this spring has a much shorter profile than the previous spring.

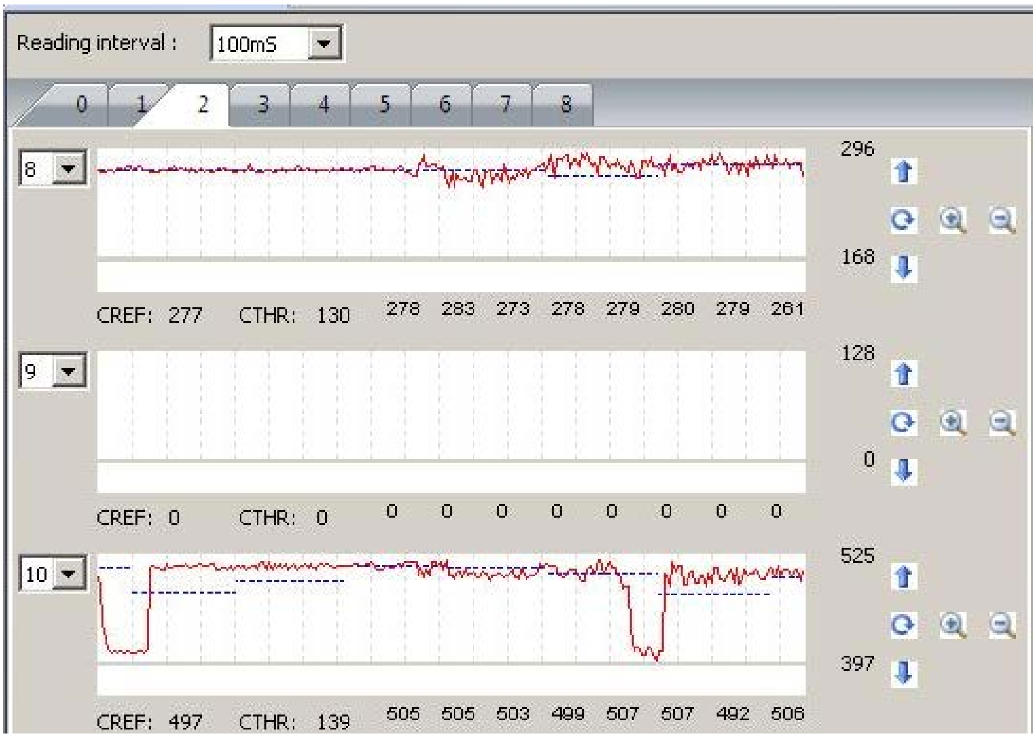

Figure 7

Results for spring 2 is shown in Figure 8.

Figure 8

The final spring configuration is for spring 1 and is shown in Figure 9. With this configuration it is difficult to determine the touch event from the noise. Though filtering and processing might help this will be a marginal design under most circumstances where noise is involved.

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Figure 9

4. Summary

Spring interfaces become a useful tool when creating touch panel interfaces for many applications. The choice of the spring is critical to achieving acceptable performance. As can be seen from the data the optimum spring design would have a cap or front panel conductive area which is consistent with the 10-15 mm pad recommendation for sensor interfaces. However, the performance of a normal helical spring design with the panel interface diameter at 12 mm without a cap provided reasonable performance. A small diameter spring is much like a small diameter sensor pad, the performance is very marginal when noise is considered.

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Revision Record

Rev.	Date	Description	
		Page	Summary
1.00	May 27, 2013	-	First edition

General Precautions in the Handling of MPU/MCU Products

The following usage notes are applicable to all MPU/MCU products from Renesas. For detailed usage notes on the products covered by this manual, refer to the relevant sections of the manual. If the descriptions under General Precautions in the Handling of MPU/MCU Products and in the body of the manual differ from each other, the description in the body of the manual takes precedence.

1. Handling of Unused Pins
   Handle unused pins in accord with the directions given under Handling of Unused Pins in the manual.
   — The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible. Unused pins should be handled as described under Handling of Unused Pins in the manual.
2. Processing at Power-on
   The state of the product is undefined at the moment when power is supplied.
   — The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the moment when power is supplied.
   In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the moment when power is supplied until the reset process is completed.
   In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the moment when power is supplied until the power reaches the level at which resetting has been specified.
3. Prohibition of Access to Reserved Addresses
   Access to reserved addresses is prohibited.
   — The reserved addresses are provided for the possible future expansion of functions. Do not access these addresses; the correct operation of LSI is not guaranteed if they are accessed.
4. Clock Signals
   After applying a reset, only release the reset line after the operating clock signal has become stable. When switching the clock signal during program execution, wait until the target clock signal has stabilized.
   — When the clock signal is generated with an external resonator (or from an external oscillator) during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Moreover, when switching to a clock signal produced with an external resonator (or by an external oscillator) while program execution is in progress, wait until the target clock signal is stable.
5. Differences between Products
   Before changing from one product to another, i.e. to one with a different type number, confirm that the change will not lead to problems.
   — The characteristics of MPU/MCU in the same group but having different type numbers may differ because of the differences in internal memory capacity and layout pattern. When changing to products of different type numbers, implement a system-evaluation test for each of the products.

SALES OFFICES

Renesas Electronics Corporation

http://www.renesas.com

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Renesas Electronics America Inc.
2880 Scott Boulevard Santa Clara, CA 95050-2554, U.S.A.
Tel: +1-408-588-6000, Fax: +1-408-588-6130

Renesas Electronics Canada Limited
1101 Nicholson Road, Newmarket, Ontario L3Y 9C3, Canada
Tel: +1-905-898-5441, Fax: +1-905-898-3220

Renesas Electronics Europe Limited
Dukes Meadow, Millboard Road, Bourne End, Buckinghamshire, SL8 5FH, U.K
Tel: +44-1628-651-700, Fax: +44-1628-651-804

Renesas Electronics Europe GmbH
Arcadiastrasse 10, 40472 Düsseldorf, Germany
Tel: +49-211-65030, Fax: +49-211-6503-1327

Renesas Electronics (China) Co., Ltd.
7th Floor, Quantum Plaza, No.27 ZhiChunLu Haidian District, Beijing 100083, P.R.China
Tel: +86-10-8235-1155, Fax: +86-10-8235-7679

Renesas Electronics (Shanghai) Co., Ltd.
Unit 204, 205, AZIA Center, No.1233 Lujiazui Ring Rd., Pudong District, Shanghai 200120, China
Tel: +86-21-5877-1818, Fax: +86-21-6887-7858 / -7898

Renesas Electronics Hong Kong Limited
Unit 1601-1613, 16/F., Tower 2, Grand Century Place, 193 Prince Edward Road West, Mongkok, Kowloon, Hong Kong
Tel: +852-2886-9318, Fax: +852 2886-9022/9044

Renesas Electronics Taiwan Co., Ltd.
13F, No. 363, Fu Shing North Road, Taipei, Taiwan
Tel: +886-2-8175-9600, Fax: +886 2-8175-9670

Renesas Electronics Singapore Pte. Ltd.
80 Bendemeer Road, Unit #06-02 Hyflux Innovation Centre Singapore 339949
Tel: +65-6213-0200, Fax: +65-6213-0300

Renesas Electronics Malaysia Sdn.Bhd.
Unit 906, Block B, Menara Amcorp, Amcorp Trade Centre, No. 18, Jln Persiaran Barat, 46050 Petaling Jaya, Selangor Darul Ehsan, Malaysia
Tel: +60-3-7955-9390, Fax: +60-3-7955-9510

Renesas Electronics Korea Co., Ltd.
11F., Samik Lavied' or Bldg., 720-2 Yeoksam-Dong, Kangnam-Ku, Seoul 135-080, Korea
Tel: +82-2-558-3737, Fax: +82-2-558-5141

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