Freescale Semiconductor
Application Note

MPR121 Jitter and False Touch Detection

INTRODUCTION

Touch acquisition takes a few different parts of the system in order to detect touch. The baseline filter and touch detection are tightly coupled. The purpose of the touch detection block is to use the baseline value and the 2nd level filter data to determine when a user has touched an electrode. The electrodes are independently configured using the Touch Threshold and Release Threshold registers. The global Debounce register also controls when a touch is detected by adding some minimal delay. The data is then output through a couple of registers: Filtered Data High, Filtered Data Low, Baseline Data and two touch output registers.
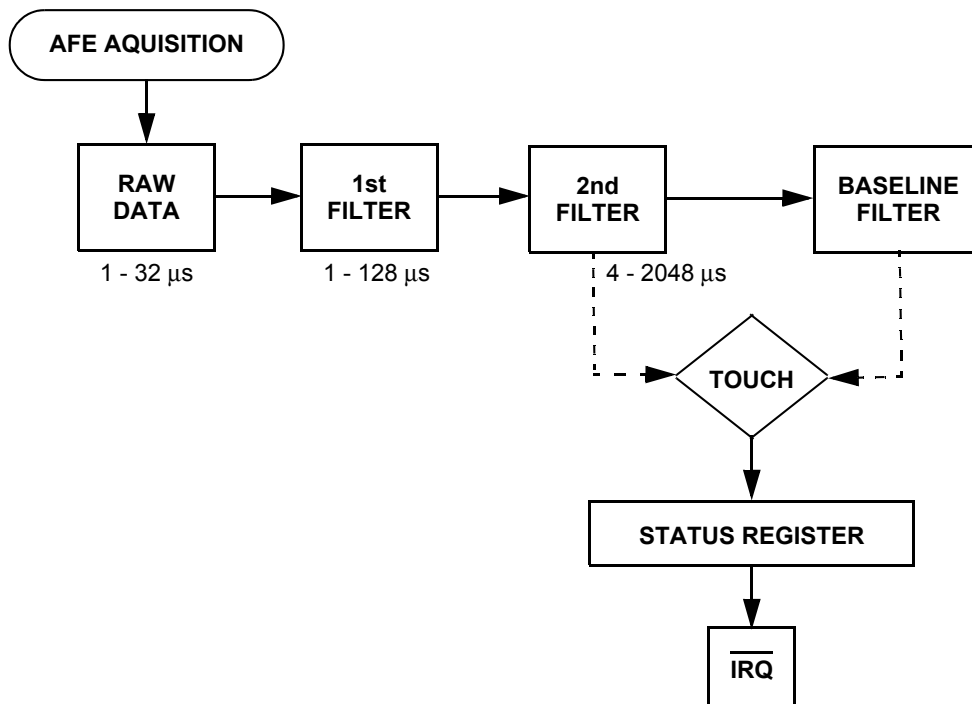

Figure 1. Data Flow in the MPR121

First, the MPR121 touch sensor detects touch by the methods in this application note, and the data is output through the first two registers in the map. The two touch status registers both trigger an interrupt on any change of the data. Thus, as a touch happens (bit is set) an interrupt will be triggered, and when a touch is released (bit is cleared) it will also trigger. To clear the interrupt all you must do is initiate a I2C communication, with the intent that you read register 0x00 and 0x01 to determine which electrodes are touched.
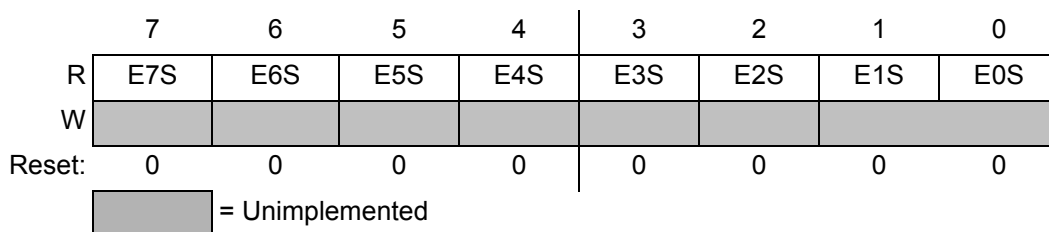
TOUCH STATUS REGISTER 0

	7	6	5	4	3	2	1	0
R	E7S	E6S	E5S	E4S	E3S	E2S	E1S	E0S
W								
Reset:	0	0	0	0	0	0	0	0

= Unimplemented

Figure 2. Touch Status Register 0

Table 1. Touch Status Register 0 Field Descriptions

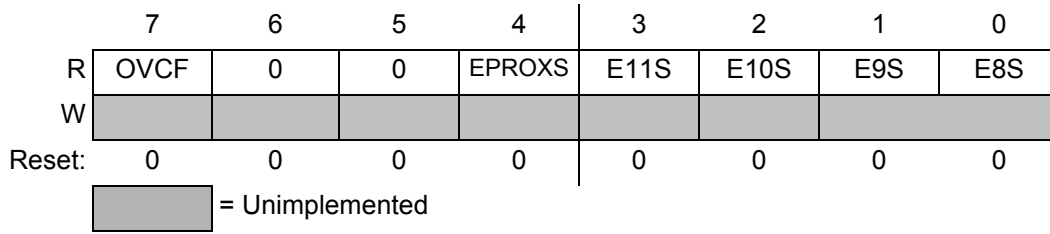| Field	Description
7 E7S	Electrode 7 Status – The Electrode 7 Status bit shows touched or not touched. 0 – Not Touched 1 – Touched
6 E6S	Electrode 6 Status – The Electrode 6 Status bit shows touched or not touched. 0 – Not Touched 1 – Touched
5 E5S	Electrode 5 Status – The Electrode 5 Status bit shows touched or not touched. 0 – Not Touched 1 – Touched
4 E4S	Electrode 4 Status – The Electrode 4 Status bit shows touched or not touched. 0 – Not Touched 1 – Touched
3 E3S	Electrode 3 Status – The Electrode 3 Status bit shows touched or not touched. 0 – Not Touched 1 – Touched
2 E2S	Electrode 2 Status – The Electrode 2 Status bit shows touched or not touched. 0 – Not Touched 1 – Touched
1 E1S	Electrode 1 Status – The Electrode 1 Status bit shows touched or not touched. 0 – Not Touched 1 – Touched
0 E0S	Electrode 0 Status – The Electrode 0 Status bit shows touched or not touched. 0 – Not Touched 1 – Touched

TOUCH STATUS REGISTER 1

	7	6	5	4	3	2	1	0
R	OVCF	0	0	EPROXS	E11S	E10S	E9S	E8S
W								
Reset:	0	0	0	0	0	0	0	0

[ ] = Unimplemented

Figure 3. Touch Status Register1

Table 2. Touch Status Register 1 Field Descriptions

Field	Description
7 OVCF	Over Current Flag – The Over Current Flag will be set any time the wrong value of Rext is connected to the MPR121's Rext pin. This is to protect the part from high current that could result from an incorrect resistor value. 0 – Correct Rext resistor value 1 – Incorrect Rext resistor value
4 EPROXS	Electrode PROX Status – The Electrode PROX Status bit shows touched nor not touched. 0 – Not Touched 1 – Touched
3 E11S	Electrode 11 Status – The Electrode 11 Status bit shows touched or not touched. 0 – Not Touched 1 – Touched
2 E10S	Electrode 10 Status – The Electrode 10 Status bit shows touched or not touched. 0 – Not Touched 1 – Touched
1 E9S	Electrode 9 Status – The Electrode 9 Status bit shows touched or not touched. 0 – Not Touched 1 – Touched
0 E8S	Electrode 8 Status – The Electrode 8 Status bit shows touched or not touched. 0 – Not Touched 1 – Touched

The next registers shown are used to provide raw data information and baseline information. The values in these registers and how they go together are described in this application note and others.
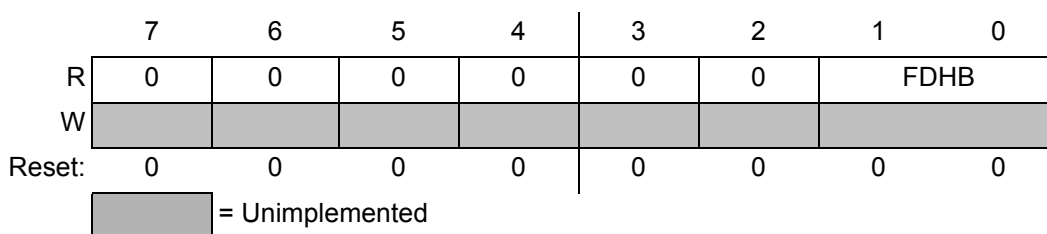
FILTER DATA HIGH

	7	6	5	4	3	2	1	0
R	0	0	0	0	0	0	FDHB	
W								
Reset:	0	0	0	0	0	0	0	0

☐ = Unimplemented

Figure 4. Filtered Data High Register

Table 3. Filtered Data High Register Field Descriptions

Field	Description
7:0 FDHB	Filtered Data High Bits – The Filtered Data High Bits displays the higher 2 bits of the 10 bit filtered A/D reading. 00 Encoding 0 ~ 11 Encoding 3

FILTERED DATA LOW

	7	6	5	4	3	2	1	0
R				FDLB				
W								
Reset:	0	0	0	0	0	0	0	0

☐ = Unimplemented
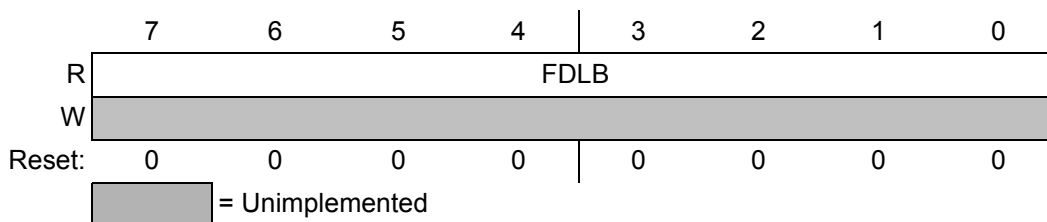
Figure 5. Filtered Data Low Register

Table 4. Filtered Data Low Register Field Descriptions

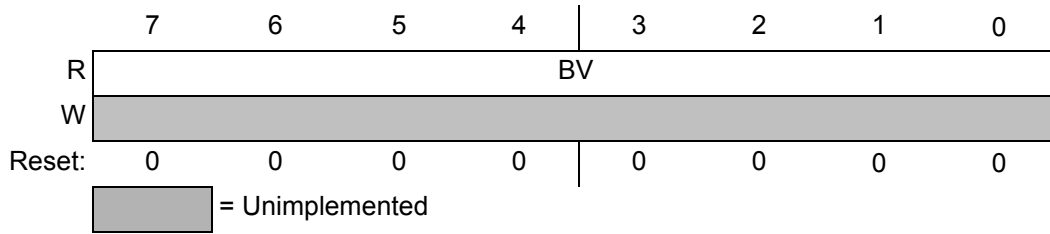| Field	Description
7:0 FDLB	Filtered Data Low Byte – The Filtered Data Low Byte displays the lower 8 bits of the 10 bit filtered A/D reading. 00000000 Encoding 0 ~ 11111111 Encoding 255

BASELINE VALUE

	7	6	5	4	3	2	1	0
R				BV				
W								
Reset:	0	0	0	0	0	0	0	0

[gray box] = Unimplemented

Figure 6. Filtered Data High Register

Table 5. Filtered Data High Register Field Descriptions

Field	Description
7:0 BV	Baseline Value – The Baseline Value byte displays the higher 8 bits of the 10 bit baseline value. 00000000 Encoding 0 – The 10 bit baseline value is between 0 and 3. ~ 11111111 Encoding 255 – The 10 bit baseline value is between 1020 and 1023.

In this system, a touch is defined as any time the difference between the Filtered Data and the Baseline Value is greater than the threshold. Since this calculation is done totally internal to the part, it is unnecessary for the user to actually do this math in the software. If it were being done, the steps would be to first combine the Filtered Data Low and Filtered Data High values into a single 10-bit number. Thus,

$$Data = Filtered\ Data\ High \bullet 256 + Filtered\ Data\ Low$$

The baseline is then shifted to the left to make it equal scale to the Data.

$$Baseline = Baseline\ Value \bullet 4$$

Internally to the device, the full 10-bit value is stored, but as this level of precision is not necessary as the low two bits are disregarded for output. The Touch Threshold is a user defined value. There is both a touch and an un-touch threshold to provide hysteresis.
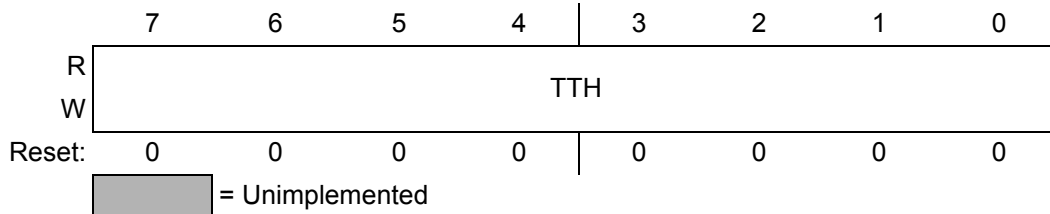
TOUCH THRESHOLD REGISTER

	7	6	5	4	3	2	1	0
R				TTH				
W								
Reset:	0	0	0	0	0	0	0	0

[gray box] = Unimplemented

Figure 7. Touch Threshold Register

Table 6. Touch Threshold Register Field Descriptions

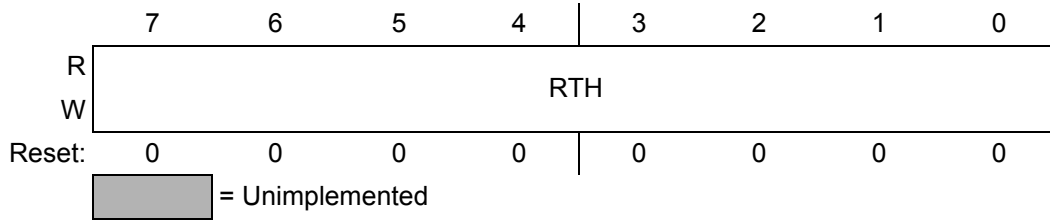| Field	Description
7:0 TTH	Touch Threshold – The Touch Threshold Byte sets the trip point for detecting a touch. 00000000 Encoding 0 ~ 11111111 Encoding 255

RELEASE THRESHOLD REGISTER

	7	6	5	4	3	2	1	0
R								
W				RTH				
Reset:	0	0	0	0	0	0	0	0

= Unimplemented

Figure 8. Release Threshold Register

Table 7. Release Threshold Register Field Descriptions

Field	Description
7:0 RTH	Release Threshold – The Release Threshold Byte sets the trip point for detecting a touch. 00000000 Encoding 0 ~ 11111111 Encoding 255

For the system to recognize a touch the delta must be greater than the Touch Threshold.

$$Delta = Baseline - Data$$

$$Trigger\ Touch \rightarrow Delta > Touch\ Threshold$$

A release is triggered when the Delta falls below the Release Threshold. This can happen for both changes to the Baseline and actual Data changes. To understand how the Baseline can change, refer to AN3891.

$$Trigger\ Release \rightarrow Delta < Touch\ Threshold$$

AN3892

DEBOUNCE TOUCH AND RELEASE REGISTER

The last register available in this set is the Debounce register. The Debounce register maintains the accuracy of touch and releases by further improving the performance. The debounce allows two different settings to prevent bounce in the end system. If the value is set to 0x22, the requirement would be three sequential changes in status before the change would be recognized.

	7	6	5	4	3	2	1	0
R	0		DR		0		Dt	
W			DR				Dt	
Reset:	0	0	0	0	0	0	0	0

= Unimplemented
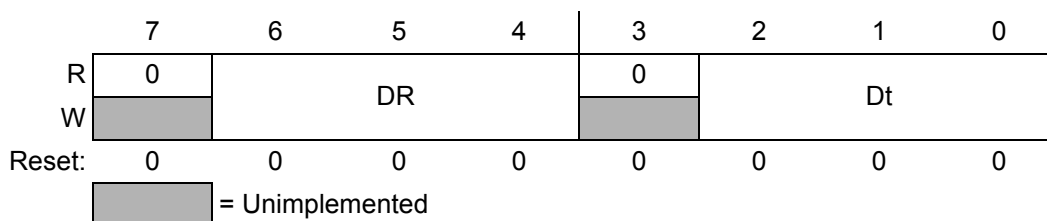
Figure 9. Debounce Touch and Release Register

Table 8. Debounce Touch and Release Register Field Descriptions

Field	Description
6:4 DR	Debounce Release – The Debounce Release determines the number of sequential release detections before an interrupt is triggered and a release is reported. 000 Encoding 0 - Consecutive releases detection before Status change is 1 001 Encoding 1 - Consecutive releases detection before Status change is 2 ~ 007 Encoding 7 - Consecutive releases detection before Status change is 8
2:0 DT	Debounce Touch – The Debounce Touch determines the number of sequential touch detections before an interrupt is triggered and a touch is reported. 000 Encoding 0 - Consecutive touch detection before Status change is 1 001 Encoding 1 - Consecutive touch detection before Status change is 2 ~ 007 Encoding 7 - Consecutive touch detection before Status change is 8

CONCLUSION

The use of each of the features together can have a great effect of the jitter and false couch rejection. Jitter is prevented by utilizing the two threshold settings. Thus the provided hysteresis prevent Jitter on the data from going through the to the output Depending on environmental conditions, the Debounce can be used to eliminate the remainder of dramatic change of the signal that aren't really touches.

Additional filtering can be done before the data gets to the touch detection system. Refer to Freescale Application Note AN3890.

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