



# MPR121 Capacitance Sensing — Filtering and Timing

## INTRODUCTION

The capacitance sensing front end of the MPR121 produces data at extremely high rates, which significantly improves the capabilities of a filtering system. The capacitance engine described in AN3889 act on a  $1\ \mu\text{s}$  -  $32\ \mu\text{s}$  per sample data rate. This application note will discuss the first and second level filters in the MPR121 and how they impact timing and power consumption.

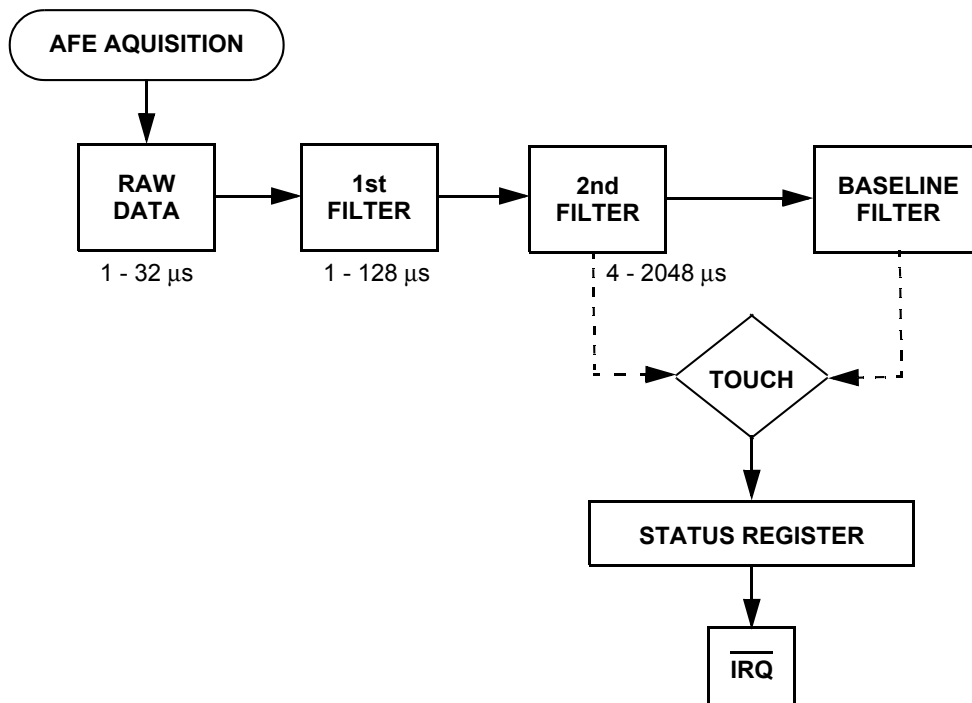


Figure 1. Data Flow in the MPR121

The first level filter is configured through the use of the First Filter Iterations (FFI) and the Charge Discharge Time (CDT).

### AFE CONFIGURATION REGISTER

The AFE Configuration Register is used to set both the CDC and the number of samples taken in the lowest level filter. The address of the AFE Configuration Register is 0x5C.

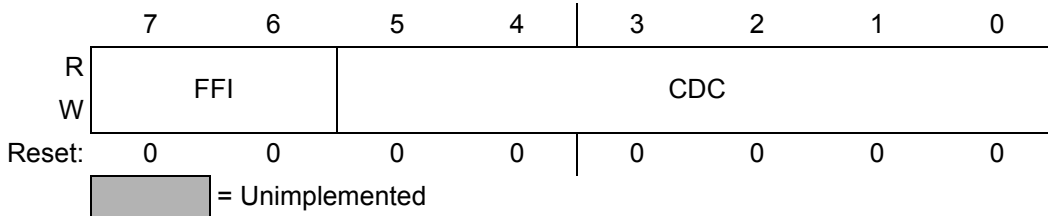


Figure 2. AFE Configuration Register

Table 1. AFE Configuration Register Field Descriptions

Field	Description
7:6 FFI	First Filter Iterations – The first filter iterations field selects the number of samples taken as input to the first level of filtering. 00 Encoding 0 – Sets samples taken to 6 01 Encoding 1 – Sets samples taken to 10 10 Encoding 2 – Sets samples taken to 18 11 Encoding 3 – Sets samples taken to 34
5:0 CDC	Charge Discharge Current – The Charge Discharge Current field selects the supply current to be used when charging and discharging an electrode. 000000 Encoding 0 – Disables Electrode Charging 000001 Encoding 1 – Sets the current to 1µA ~ 111111 Encoding 63 – Sets the current to 63 µA

The properties of the filter are determined by these two settings, but the CDT is determined by the capacitance being measured, as discussed in AN3889. The FFI sets the number of samples being measured. The result of an FFI setting of 6 or 0x00 would be to take 6 samples, toss the maximum and minimum, then average the remaining 4 samples. The results of an oscilloscope output on an electrode with the setting of FFI = 0x00 and CDT is shown in Figure 3.

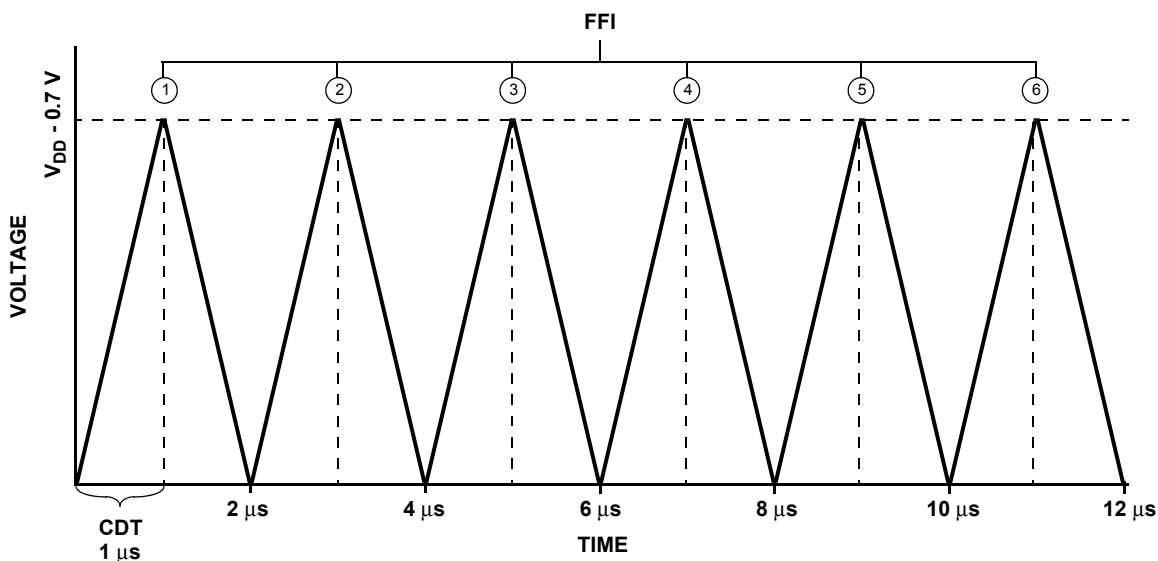
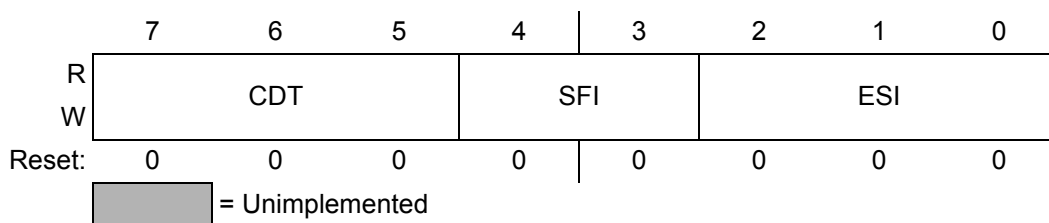


Figure 3.

The first level of filtering delivers data to a second filter stage. The second filter stage averages samples over more time, in this example anywhere from 1 ms to 128 ms. Then a value can be selected for how many samples should be averaged.

## FILTER CONFIGURATION REGISTER



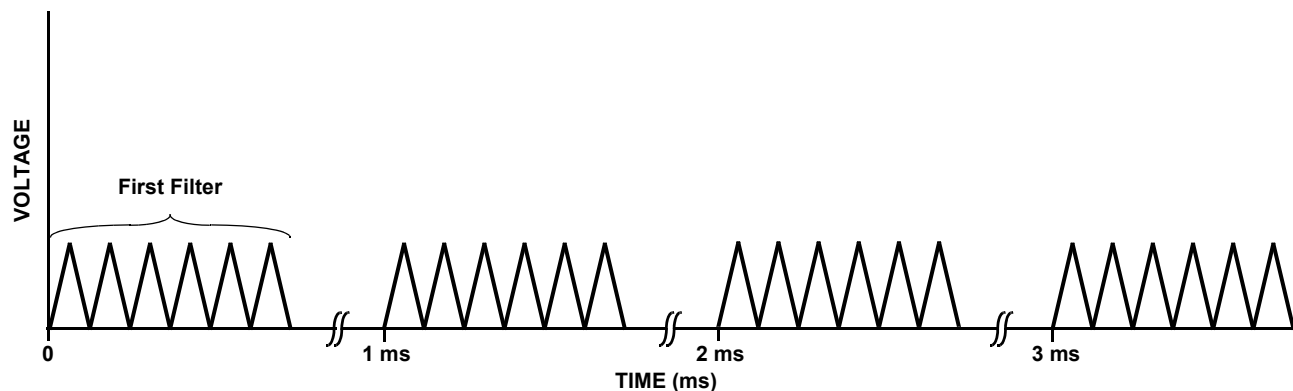
**Figure 4. Filter Configuration Register**

**Table 2. Filter Configuration Register Field Descriptions**

Field	Description
7:5 CDT	Charge Discharge Time – The Charge Discharge Time field selects the amount of time an electrode charges and discharges. 000 Encoding 0 – Invalid 001 Encoding 1 – Time is set to 0.5 $\mu$ s 010 Encoding 2 – Time is set to 1 $\mu$ s ~ 111 Encoding 7 – Time is set to 32 $\mu$ s.
4:3 SFI	Second Filter Iterations – The Second Filter Iterations field selects the number of samples taken for the second level filter. 00 Encoding 0 – Number of samples is set to 4 01 Encoding 1 – Number of samples is set to 6 10 Encoding 2 – Number of samples is set to 10 11 Encoding 3 – Number of samples is set to 18
2:0 ESI	Electrode Sample Interval – The Electrode Sample Interval field selects the period between samples used for the second level of filtering. 000 Encoding 0 – Period set to 1 ms 001 Encoding 1 – Period set to 2 ms ~ 111 Encoding 7 – Period set to 128 ms

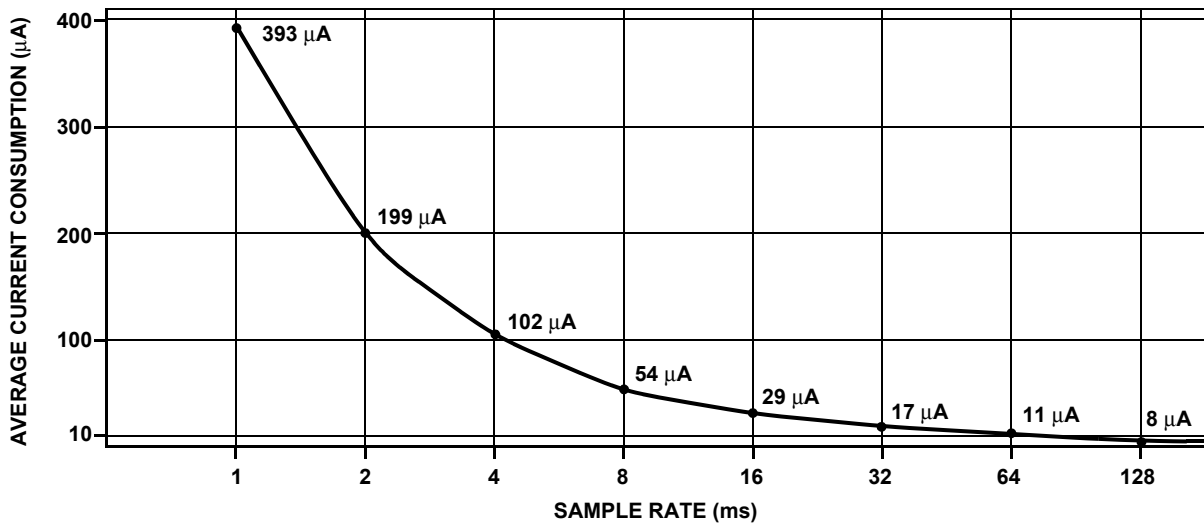
**Note:** In most cases the CDT in this register is not used. It will normally be auto-configured as described in AN3889

While the 1 ms to 128 ms does affect the filtering, the main purposed of adjusting the sample rate would be to change the average current consumption of the device. [Figure 5](#) illustrates this adjustment.



**Figure 5.**

From this, it can be seen that the 12  $\mu$ s up time from the 1 ms samples results in a very low percent of duty cycle. This results in a very low average current consumption.



**Figure 6. Average Supply Current**

The output data is the Filtered Data High and Low is the data coming out of the second stage filter. This means that the response time of the output is the SFI times the ESI. This usually results in 16 ms and 4 iterations being used to get 64 ms response time while still optimizing the power consumption. At each 64 ms, a decision would be made regarding touch by comparing the Baseline with the filtered data output, resulting in a worst case of the full 64 ms plus half the previous cycle, equalling 96 ms.

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