# Capacitive Touch/Proximity Sensor FAQs

# FAQs Capacitive Touch/Proximity Sensor

**What are the key considerations in the design of the sensing electrode?**

**Answer:**

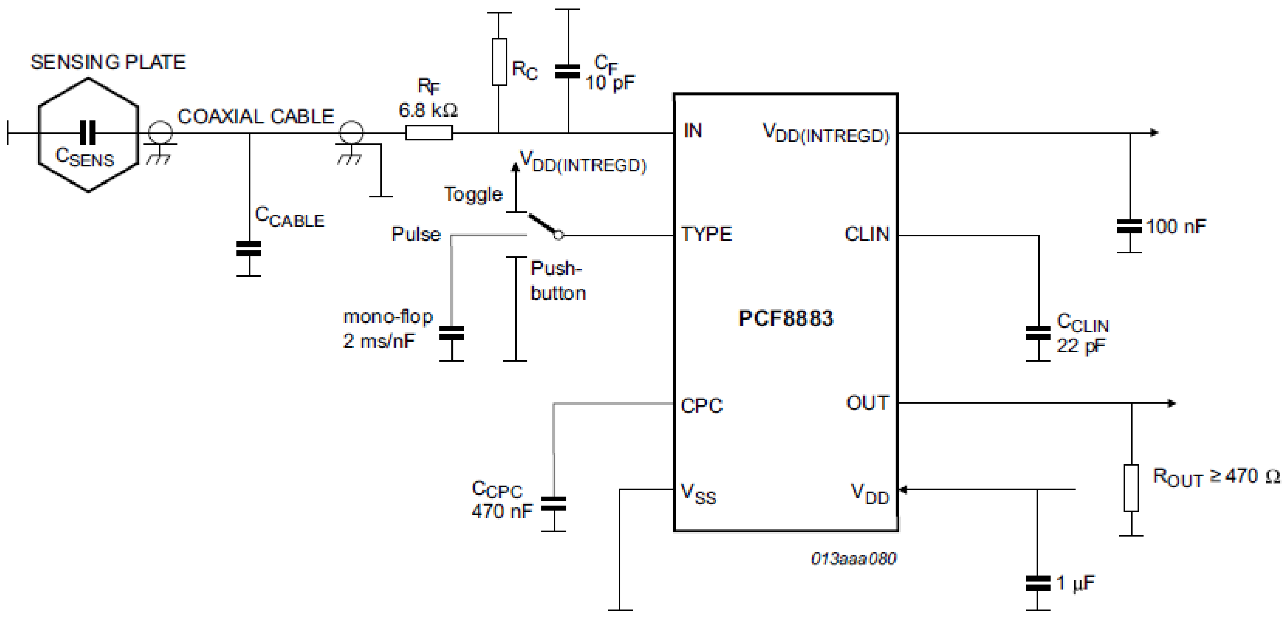
NXP’s capacitive switches use a patented digital technique (patent from Edisen) to detect a change of capacitance on the device input. In order to use this switch, the following must first be defined:

- mechanical outline and materials to be used
- the desired switching distance from the sensing plate and
- application specific optimal approach speed sensitivity

# FAQs - Capacitive Touch/Proximity Sensor

**What is a good starting point for the typical application circuit for the PCF8883?**

**Answer:**




Coaxial cable needed for distant sensing plates in noisy environments.

**Fig 1. Typical application circuit**

# FAQs Capacitive Touch/Proximity Sensor

**What are the key parameters that influence the switching behavior of the PCF8883?**

**Answer:** The adaption of the switch to a particular application usually requires to adjust several components because certain parameters can be influenced by one or more factors. Factors such as: sensor area, sensor environment, and triggering must be taken into account. These aspects must be considered for the optimal behavior of the switch.

The circuit has three parameters that influence the switching behavior. Below they are listed in order of their influence:

- • **Switch sensitivity ($C_{CPC}$ capacitance between CPC and VSS)**
- • **Calibration of the total capacitance on the sensor input ($R_C$ between IN and VSS)**
- • **Switching speed ($C_{CLIN}$ between CLIN and VSS)**

# FAQs - Capacitive Touch/Proximity Sensor

**What is the purpose of Rc in Figure 1. Typical application circuit for the PCF8883?**

**Answer:** $R_C$ is only necessary to unload the sensor input when the capacitance of the sensing plate and the capacitance of the coaxial cable or PCB trace is higher than 60 pF. This is the upper limit of the input capacitance.

- Check the switching by touching the sensor plate although the final application will use proximity sensing. Assuming that the default value of $C_{CPC}$ (470 nF) is used, switching should occur. If not, the $R_C$ resistance can be gradually reduced till switching occurs. The lowest value allowed is 20 kOhm.

# FAQs - Capacitive Touch/Proximity Sensor

**According to the PCF8883 data sheet , the total input capacitance should be between 10 pF to 60 pF in order for the control loop to work correctly and reliably. How is this total capacitance measured or determined?**

**Answer:**

In practice, it is normally impossible to measure this capacitance. Alternatively, the voltage on $C_{CPC}$ can be measured. Ideally, the operating voltage on $C_{CPC}$ should be:

$V_{DD(INTREGD)}/2$

This measurement must be done with a high impedance probe (Rin > 5 Gohm) since this point has a high resistance1. The lower limit for $R_C$ is approximately 20 kohm. It should be noted, that the IC has an internal 50 kohm resistor connected in parallel to $R_C$ (pin IN to VSS). When $R_C$ is less than 20 kohm, higher internal currents are flowing and the precision of the device is declining.

# FAQs Capacitive Touch/Proximity Sensor

**What if sensitivity is poor with the recommended CCPC value of 470 nF?**

**Answer:**

Adjustments are usually necessary when:

1. The sensor area is small and the triggering area is comparable or smaller. For example, if the sensor is used in a keyboard, the keys may have a small area. The area of a finger is comparable to the sensor area. The switch must be fine-tuned such that neighboring switches do not react.

2. The distance between the sensor plate and triggering object is larger than the sensor plate area (switching at a distance).

3. Switching through materials having different permittivity $\varepsilon_r$ is desired.

The second point is actually a special case of the third point. The complexity is caused by the fact that the switching point is not solely defined by the sensing plate but also by the situation of the air (and its permittivity $\varepsilon_r$) between the plate and the triggering object. Since the nature of air can change slightly depending on conditions, the situation for proximity switching is not as well defined as it is when the plate has to be touched. This makes it difficult to give a precise range for switching at a distance.

# FAQs Capacitive Touch/Proximity Sensor

**How does $C_{CLIN}$ define the internal sampling frequency and how does it affect performance?**

**Answer:**

The sampling period is given by:

$T(fk)[\mu s] = 300\ \mu s + C_{CLIN}[pF] \times 33\ \mu s/pF$

This means:

1) The sensor reacts faster when the frequency is increased since the necessary number of comparisons is reached in less time.

2) This also means the sensor self-calibrates to new environments more quickly with the result that a slow moving hand will no longer cause the sensor to switch.

3) Another consequence of increasing the sampling frequency is that the sensor reacts to quick changes at a distance with higher sensitivity.

4) This effect in 3) can be enhanced by increasing $C_{CPC}$ or increasing the sensing electrode area.

5) To determine the value of $C_{CLIN}$, it is important to know the normal “approach speed” of the triggering object. For instance, a machine mores faster than a human hand.

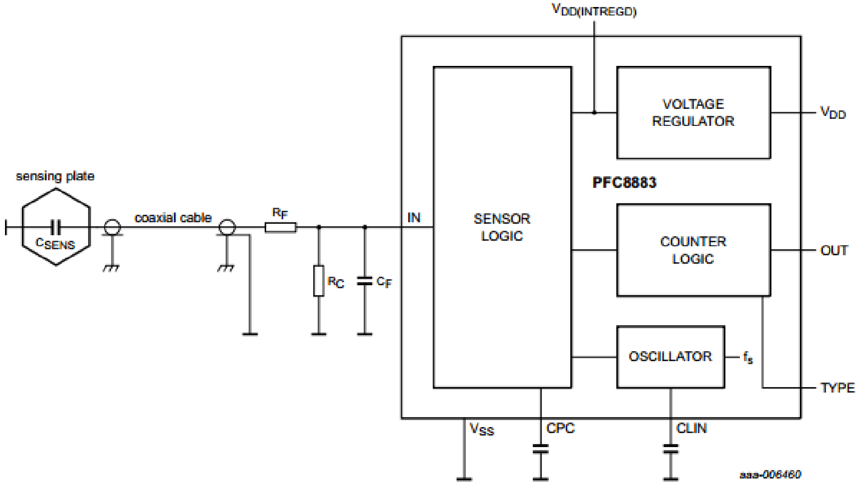
# FAQs Capacitive Touch/Proximity Sensor

**When are RF and CF employed on the input?**

**Answer:** $R_F$ and $C_F$ are used to create a low pass filter placed closed to sensor input pin. This filter and its frequency characteristics are described in AN11157. Depending on the RF noise in the environment and the spectral characteristics, the value of $R_F$ can be range from 0 ohms up to 10kohms without any significant impact on sensitivity.

The value of $C_F$ requires consideration of the total capacitance load on the sensor input and it can be increased as long as the voltage on the CPC pin is kept at 0.5 * $V_{DD(INTREGD)}$.

-




$C_{SENS}$ = sensing plate capacitance.
$R_C$ = external discharge (pull-down) resistor.
$R_F$ = low pass filter resistor.
$C_F$ = low pass filter capacitor.

Fig 5. Functional principle of the PCF8883

# FAQs Capacitive Touch/Proximity Sensor

**How is the PCF8885 compare with the PCF8883 and PCF8886?**

**Answer:**

**Comparison:**

- The PCF8885 is an eight channel cap sensor with $I^2C$-bus control
- Whereas, the PCF8883 is a single channel cap sensor and PCF8886 is a dual channel cap sensor. Neither have $I^2C$-bus control
- Similar calibration procedure is necessary for all three devices

# FAQs Capacitive Touch/Proximity Sensor

**What factors affect sensitivity and capacitance changes?**

**Answer:**

Many factors can increase and decrease the sensitivity of the switch. The sensitivity is a function of:

- The approach speed of the triggering object
- The area of the sensor plate (or electrode) and the area of the triggering object
- The shape of the sensor plate and the triggering object
- The nature and thickness of the material between the electrodes. Note: air gaps not recommended
- The plate (or electrode) orientation
- The coupling between the sensor area, sensor triggering object, and the ground (earth)

# FAQs Capacitive Touch/Proximity Sensor

**What is this feature in the NXP Cap Sensors called auto calibration?**

**Answer:**

- Patented technique that maintain calibration as sensing object triggers the cap sensor switch and provides an output.
- The cap sensor is restored to its initial condition by the internal auto calibration circuitry.
- Once the design is calibrated, the cap sensor maintain performance due to the auto-calibration feature.