Introduction

The PE5010 is an integrated circuit to measure capacitive sensors. Typical examples for such sensors are pressure or acceleration MEMS sensors.

This application note explains how to design capacitive sensors for proximity recognition with the PE5010. A change in the dielectric, for example caused by the approach of a hand to an object with sensor elements, causes a change in capacitance. This effect can be used to detect an approach or touch of an object. The application note shows some sensor layouts, requirements and possible examples for proximity detection.

For more detailed information about the PE5010 please refer to the corresponding datasheet.

Table of Content

List of Figures

1 Revision History

Version	Date	Changes	Page
Initial Version 1.0	12/2010		

2 General

The PE5010 Integrated Circuit can be used for proximity detection in conjunction with any microcontroller featuring a SPI. It is suitable for proximity detection in a range of up to 1,5cm. This detection is ground-free.

3 Laboratory experiments

3.1 General

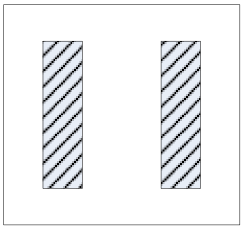
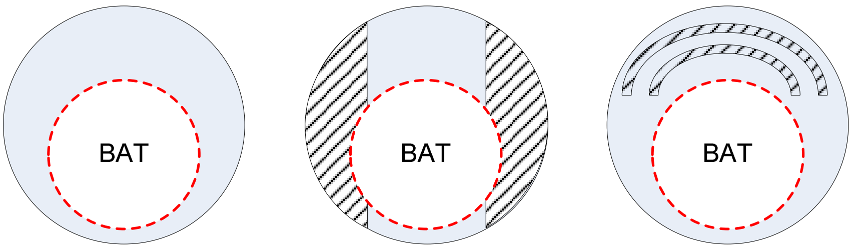


Figure 1 - General sensor layout

A general capacitive sensor layout is depicted in Figure 1. The two electrodes build a classical capacitor. The distance is fixed. The capacitance change can be caused by a change of the dielectric between both electrodes by an object or a human finger. The PE5010 measures the capacitive changes and a controller determines whether a proximity event has taken place.

3.2 Investigation

A round plastic package with a diameter of about 30mm has been used for sensor evaluation. The sensor board is mounted inside a plastic package. The purpose is to detect whether the device is close to a human body or not.
The evaluation of the sensors was performed by an approach of a hand to the package.



(a) Plastic package (battery shown with dashed line)

(b) Sensor Layout 1 in package

(c) Sensor Layout 2 in package

Figure 2 - Package and Tested sensor layouts

The sensor layouts (shaded line Figure 2 b + c) were tested with and without an inserted battery. Sensor layout in Figure 1 was also tested. The measurements were done with the EVA5010 Evaluation Kit in single-ended mode. One electrode was connected to positive input and the other to virtual ground of the PE5010. All measurements were conducted at room temperature.

Table 1: Measurement results

Sensor Layout	Figure 1	Figure *2* (b)	Figure *2* (c)
Size	4x30mm (distance between electrodes 4mm)	Diameter of package 30mm	Diameter of package 30mm
Distance*	0 ..1,5cm	0 ..1,5cm	0 ..1,5cm
Environment	air (no package)	plastic package	plastic package
Capacitance change [fF] (without battery)	200	250	250
Capacitance change [fF] (with battery)	100	40	150

***… Distance of electrodes to human body (hand)**

The results show that the sensor electrodes have not to overlap with areas of fixed potential (especially grounded areas) because the capacitance change is rapidly decreasing. The capacitance change is a measure of how secure the proximity of a human body (-part) can be recognized.
Sensor layout Figure 2 c has shown the best results in this package with and without an inserted battery.

4 Requirements for Proximity sensing

The PE5010 cannot determine a capacitance to ground. For a capacitive measurement both electrodes have to be connected to the PE5010.
The single-ended mode should be chosen. In this mode the basic capacitance has to be adjusted with a calibration routine. The basic capacitance depends on ambient humidity and temperature and on the current printed circuit board design. To get a reliable measurement result humidity and temperature on the sensor should not change too much.
The differential mode can be used under specific circumstances. The differential mode should be used if the expected capacitance change will be in a wide range (e.g. <500fF). The advantage to single-ended mode is that there is no need for calibration (basic capacitance). The disadvantage is that only one (sensor) electrode is changing. The other input has to be connected with a static capacitance. This means that only half of the accuracy is available.

An area with a fixed potential (e.g. negative pole of battery) near to the sensor has a negative effect on the useable capacitance change. The distance of a grounded area to the sensor electrodes should be as far as possible. Often only limited space is available. In this case the sensor for proximity detection should be placed next to ground area. It should be avoided that the surface of the sensor electrodes and ground area is overlapping.

Note: A typical application of the PE5010 also requires a microcontroller.

5 Applications

There is a wide field of applications for proximity detection. If the requirements (section 4) can be met, following application examples for energy saving, live assistant and event detection are possible.

- Detection if a device is being used
  - Watch is being worn
  - Mobile phone has been taken for usage
  - Headset is plugged in ear and ready to use
  - Remote control has been picked from the table
- Switches
  - Box is open/close
- Touch pads
  - Buttons

A possible application is the detection if a device is taken by an user.
In case of mobile phones it is possible to switch the display off and enter into certain other energy saving modes when the phone is not kept by the user. If the user takes the phone, then the display will be activated (see Figure 3).

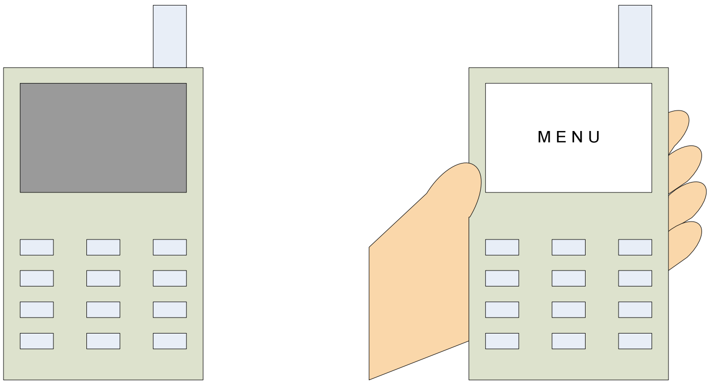


Figure 3 - Application for mobile phones

The same application is possible for a Bluetooth headset. A measureable capacitance change will occur when the sensor electrodes are near to the ear. This change can be used to switch the headset from “standby” to “active” state.
Another application is to detect if a measurement unit (e.g. heart rate monitor) is being worn. For example in sports belts with heart rate monitor. Data are valid and should be only transmitted if the belt is being worn.
A separate application note for “Proximity Switch, touch sensor” is available. It describes sensor layouts and other design considerations.

SERMA PRODUCTIVITY ENGINEERING

6 Contact

Germany

Stuttgart

Productivity Engineering
Process Integration GmbH
Behringstrasse 7
D-71083 Herrenberg
Germany
Phone.: +49 (0) 70322798 0
Fax: +49 (0) 70322798 29
Email: info@pe-gmbh.com
Web: www.pe-gmbh.com

Dresden

Productivity Engineering GmbH
Branch
Sachsenallee 9
D-01723 Kesselsdorf
Germany
Phone.: +49 (0) 35204777 00
Fax: +49 (0) 35204777 000
Email: info@pe-gmbh.com

Important Notice