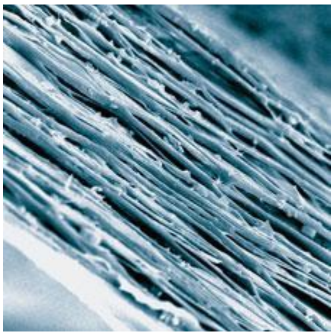
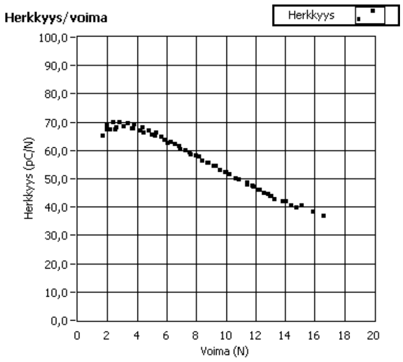
The following is a series of questions which are often asked by customers related to HiUP technologies

How does the sensor work?

The sensors' inner capacitance changes through pressure which converts into thickness change of the HiUP Electromechanical film. This capacitance change generates current which is measured and amplified.





Typical pressure – current response pC/N

Typical applications

Dynamic force measurements, environmental monitoring for example:

1) **Vibration**
2) **Shocks & impacts**
3) **Weight**
4) **Pressure division**
5) **Part fitting**
6) **Medical cooperation and sports**

What effects do thermal shocks have on the sensor and HiUP material?

The HiUP sensors' thermal coefficient is so small that thermal shock produced from room temperature air to boiling water at 98-100⁰C does not cause actuation of sensor. The test was done with the sensor and normal amplifier. Exposure times ranged from 5 seconds to 10 seconds of boiling running water. Sensor worked normally after tests.

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What effect do water and other magnetic and electric field altering substances have on the sensor?
The sensor is not based on electrical or magnetic fields and thusly the sensor is unaffected by objects that do not create sufficient pressure on the active areas. Wet environments are no problem for the HiUP sensor.

What is the resistance against humidity and moisture?
There are multiple factors affecting sensor resistance against moisture and water: a) sensor assembly – sensor is assembled between plastic films and normally glued together. Active areas are sealed within the sensor assembly. E.g. sensor submerged into a water works without problems even after hours of exposure to water b) back plate – often sensor is capsulated in epoxy making it extremely hard for water or steam to penetrate to the sensor level c) overlay due measuring method no holes are needed in the front plate allowing the whole user interface to be moisture and water resistant or immune.

Thermal stability?
The sensor is stabile from -40^{o}C - +130^{o}C depending on aging of the sensor film.

What materials can be used as the surface material?
Steel, Aluminum and other metals
Plastics, acryl and polycarbonates
Rubber and Rubberized plastics
Leather, fake leather and fabrics
Glass, Glass ceramics and zircon
Wood

What is the maximum overlay thickness?
That depends on the application and surface material. As long as there is deformation or force transfer to the sensor everything goes up to centimeters.
The normal thicknesses range from 1,0 – 1,5mm for aluminum, 1,0 mm for steel, 1,0 – 3,0mm for acryl and plastics. Material decisions are made on a case by case basis to suit the user environment and design.

What are possible sensor sizes, dimensions and distance between sensor active areas?
Sensor sizes and shape can vary a lot. Square buttons of 2mm x 2mm to round sensors with diameter of 5 cm. Miminum sensor size is 1mm^2, while the largest sensors can be square meters.

The distance between sensors is dependent on the following factors: a) surface thickness b) surface bending c) amplifying levels d) mechanical structure e) sensor structure. Due multiple factors there is no minimum distance for the buttons. As a rule of thumb 1-3mm is enough.

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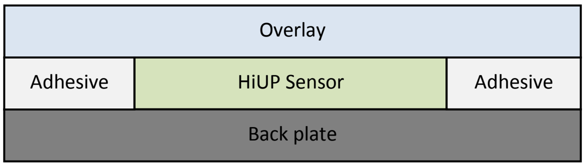
What are the demands for mechanics?

The sensor needs a back plate or surface behind sensor, usually it is enough that the back plate is more rigid than surface material. This is to allow force to press the sensor together to generate current change. As a rule of thumb back plate needs to be as strong as the front plate or stronger. Back plate is only needed where the active areas are located. Mechanics need to allow thickness change in the sensor between 100nm to 200nm in minimum depending on amplifying levels.

Example assembly:



Electronics and amplifier

The sensor needs to be coupled with an amplifier to increase the output of sensor to more measureable levels. Afterwards the amplifier output can be actualized with comparator or couple with microprocessor to enable standard protocols and code for e.g. rotations, sweeps etc.

The electronics footprint depending on application varies from few mm^2 to 8cm^2 and 4-5mm thickness. The electronics can be run with a battery. Connection to e.g. a mobile phone is possible with RF or BTLE connection.

What feedback methods can be exploited with HiUP?

Lightning solutions LEDs, Electroluminescence lights, haptical feedback from benders or piezo, loudspeakers and beepers. Lightning modules mainly LEDs are also possible to assemble on top of sensor without losing usability.

What kind of EMC protection can be used?

Because sensor is based on pressure sensing, there are no open electrical fields. Sensors can be totally RF protected and grounded. Sensors do not act as antennae to send or to receive electrical interference.

About HiUP sensors and electromechanical sensor attributes

Sensors have long life time even in harsh environments. Life time is dependent on the surrounding mechanical structure, materials and electronic components. Sensors can be integrated at least by lamination, mechanical pressure, gluing, injection molding and molding techniques. Surface materials can vary from organic materials – fabrics, leather, rubber, wood, organic composites to metals e.g. aluminum, steel, glasses or plastics either soft or rigid depending on the application.

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By designing the encapsulation, the sensor can be used in various user environments. The sensor can be protected from environmental hazards – solvents, detergents, mechanical stress, temperature etc. The sensor can also be protected from radio frequency interferences both transmitting and receiving by exploiting printing process. Through encapsulation and design of the casing, water proof or/and spark proof applications can be manufactured. Surface thickness can vary from <0,1mm up to 2-3cm depending on material rigidness, keypad sensitivity requirements and dimensions.

The sensor is somewhat resistant to bending and also much less sensitive to forces caused by bending. This makes it good material for applications where user keypad is on hard surfaces. This also reduces overhearing. Stress forces inside material that are caused by thermal instability have minimal effect on the user interfaces' sensitivity due this attribute.

The sensors can be assembled to arched or convex surfaces opening new possibilities for system design and looks. Active areas can be highlighted by printing, gnawing, etching, laser etc. to give defined look or feel to the active areas depending on the materials. Also, integration of lightning, graphics and screens can be integrated to the user interfaces.

Our user interface systems can be calibrated analogically or digitally to respond to certain type of touch or forces. To give an example, a short <10ms low force <1N touch can be ignored and only definitive presses >1s of length and over 3N force are regarded as touch events. Using processing, complex algorithms can be defined e.g. double tap, scrolling and rotate functions to be utilized for actuating. The sensors input can be defined to actuate different things in predefined events or for different users. We can thus alter the sensitivity of active areas e.g. while driving, listening to music etc. to remove unwanted activations.

The user interface can be programmed to ignore vibrations, this enables the possibility to use vibrators – piezo, coil & magnet etc. as haptic feedback for user with or without lights and sounds.

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