List of Contents

1. Introduction........................................................................................................................................... 3
2. Technical Data......................................................................................................................................... 5
   2.1. Sensor’s X-Y position sensing layer. ................................................................................................. 5
   2.2. Pressure Sensing Layer Z..................................................................................................................... 5
3. Applications ........................................................................................................................................... 9
4. Pressure Mat Development Kit ............................................................................................................... 11
   4.1. Pressure Mat Dev Kit. Sensing Mats features .................................................................................... 11
   4.2. Pressure Mat Dev Kit. SDK 05 ............................................................................................................. 12
   4.3. Pressure Mat Dev Kit. Services included ............................................................................................. 17
5. Maintenance and Operating Instructions Dev Kits .................................................................................. 17
6. Legal Note ............................................................................................................................................. 18
The new generation of pressure measurement sensors

The flexibility of Pressure Mat Platform, along with its incredible ability to adapt to any shape and design, makes it the best solution for its integration into mats, upholstery, covers, sheets, etc. This technology allows the development of products in many sectors such as health, wellness, fitness, automation, automotive, industry and security among others.

1. Introduction

Product

The Pressure Mat Platform is based on a patented technology using proprietary conductive inks to create stretchable, thin, film pressure sensitive textiles. Sensing Tex manufacturing technology allows the customization, then conductive inks can be applied in any pattern, allowing a pressure sensing element of any shape which follows the form and flow of the textile. The surface of the fabric is thus transformed into a textile area with sensing properties.

The specific combination of materials and techniques allows the creation of a textile capable of measuring multi-touch pressure sensing. This property is used in a wide variety of textile based sensing products in a range of markets that require Pressure Mapping or heat pressure maps.

Sensing Tex offers feasibility and development services for textile based sensing products with its SDK Development Kit: an electronic module, with enough inputs to be connected with any of our Pressure Sensor standard samples. The Software Development Kit (SDK) is a data acquisition
system that allows real-time pressure maps and logging the pressure data of sensors, pressure sensors can be connected by Bluetooth® or USB.

The SDK and pressure sensors allow you to boost your projects and be able to work with quick prototyping. Visit our website www.sensingtex.com to see either more specialized Dev Kits for Mats or some of the developed products based on this Dev Kits.

Applications

Sensing Tex offers a wide variety of market applications based on its Sensing Mat Platform:

**Sensing Mats for Flooring:** This Sensing Mats can be used in Carpets and Rugs for people tracking and counting systems, (this is an effective solution for **counting people** entering and exiting events, conferences, shops, malls, and any venue where attendance or throughput information is important). It can be used as well as **presence sensing mats, gaming mats, home automation mats.**

**Exercise Mats** (Please ask for **Fitness Mat Dev Kit**)

**Sensing Mats for Bedding:** can be used in healthcare applications, pressure ulcer prevention postural and movement analysis and also in wellness as sleep tracker or as a Point of Sales System for mattress prescription (please ask for **Mattress Mat Dev Kit**).

**Sensing Mats for Seating:** can be used as part of the upholstery to monitor the occupation of seats, control panels, positioning, etc. or in healthcare for pressure ulcer prevention, postural and movement analysis. The mats can be integrated into transport systems to collect passenger usage data (please ask for **Seating Mat Dev Kit**).

**Sensing Mats for general pressure and switch applications:** can be used in order to make smart any surface you may be interested in collecting pressure maps and develop products and apps based on the recognized patterns.
2. Technical Data

The Pressure Mat Platform is based on a multi-axis and multi-touch detection technology that allows to create 3D pressure maps, knowing the X-Y coordinates of the pressure points as well as the amount of pressure applied (Z direction) on each sensor spot distributed along the textile surface.


The properties for position detection in the X-Y plane are as follows (for further information please review Switch Mat Platform Technical information):

<table>
<thead>
<tr>
<th>Property</th>
<th>Unit</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature Range (°C)</td>
<td></td>
<td>-15 – 90</td>
</tr>
<tr>
<td>Relative Humidity Range [%]</td>
<td></td>
<td>0-100</td>
</tr>
<tr>
<td>Repetitions (lifespan)</td>
<td>#</td>
<td>&gt;10⁸</td>
</tr>
<tr>
<td>Physical Characteristics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum Sensor Thickness [µm]</td>
<td></td>
<td>200</td>
</tr>
<tr>
<td>Minimum Resolution [mm]</td>
<td></td>
<td>1,5</td>
</tr>
<tr>
<td>Electrical Characteristics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dynamic Response Time Rising (99%) [ms]</td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>Dynamic Response Time Falling (99%) [ms]</td>
<td></td>
<td>20</td>
</tr>
<tr>
<td>Sensitivity Error (0,2-0,5N) [%]</td>
<td></td>
<td>0,2</td>
</tr>
</tbody>
</table>

Table 1: Technical properties x-y position detection layer

2.2. Pressure Sensing Layer Z

The characteristics of the pressure sensor in the Z plane are determined by a textile layer which combines fabric with a special ink.

The sensor’s properties in the Z plane are described in the following table:

1 Tested in the laboratory. The range of measurements described should not be considered as a limit,
Quasi-Static Response Of The Sensor

The following graph shows the quasi-static response of the conductance vs pressure for one of the pressure sensor products available in our standard Catalogue. In the graph two different behaviors can be observed. Linear behavior is observed for pressures between 0 to 2.5 Kg/cm² and a smooth curve for pressures between 2.5 - 25 Kg/cm².

![Conductance vs. Pressure Graph]

Figure 1: Pressure sensitivity rating of the Fabric Quality 8 under pressure from 0 to 25 Kg/cm²

Table 2: Technical Properties of the pressure sensor layer

<table>
<thead>
<tr>
<th>Specifications</th>
<th>Units</th>
<th>Multilayer</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Operating Conditions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature Range in Use (^{(1)})</td>
<td>[ºC]</td>
<td>-15 – 80</td>
</tr>
<tr>
<td>Relative Humidity in Use</td>
<td>[%]</td>
<td>0-100</td>
</tr>
<tr>
<td># Estimated Repetitions</td>
<td></td>
<td>&gt;10⁶</td>
</tr>
<tr>
<td><strong>Physical Characteristics</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum Thickness of Sensor Layer</td>
<td>[µm]</td>
<td>100</td>
</tr>
<tr>
<td>Distance Between Buttons</td>
<td>[mm]</td>
<td>2</td>
</tr>
<tr>
<td><strong>Electrical Characteristics</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Response Time Rising (95%)</td>
<td>[ms]</td>
<td>15</td>
</tr>
<tr>
<td>Response Time Falling (95%)</td>
<td>[ms]</td>
<td>20</td>
</tr>
</tbody>
</table>

(1) All these combinations have been laboratory tested. This range of results should not be considered as a limitation.
The following graph shows the behavior of the pressure sensor fabric in the low pressure scale (between 0 to 2.5 Kg/cm²). This scale is linear behavior with a steep slope.

![Conductance vs. Pressure](image)

**Figure 2:** Pressure sensitivity rating Fabric Quality 8 under low pressures between 0 to 2.5 Kg/cm²

In the first low pressure range, the pressure sensor hysteresis is very low, which allows to check the difference in conductance values versus different loads applied pressure cycle both uplink and downlink.

The table below shows the good fitting to a linear law for the low pressure range between 0 to 2.5 Kg/cm²:

\[
\sigma = bP + a
\]

| \(\sigma [\Omega^{-1}]\) | Conductance |
| \(P [\text{Kg/cm}^2]\) | Pressure |
| \(a = -0.00148 \Omega^{-1}\) | Initial Constant |
| \(b = 0.000013 \Omega^{-1} \text{ g}^{-1}\) | Pressure/Conductance function |
| \(R^2 = 99.96\%\) | Linear Prediction Model (ideal tending to 100\%) |
| \(H = 2.1\%\) | Hysteresis (% average variation of sensor conductance value for each pressure value into the cycle of rise and fall for each point) |
The second part of the graph corresponds to the average response of the sensor and high pressure. The slope (sensitivity) is less pronounced than in the first and the behavior is also approximately linear.

Figure 3: Pressure sensitivity rating Fabric Quality 8 under medium and high pressures between 2,5 to 25 Kg/cm²

Dynamic Pressure Sensor Response
The dynamic loading test (application of successive loading/unloading) demonstrates that the sensor gives a good dynamic response in detecting differences of pressure in steps of 55gf/cm² without errors (this test condition should not be considered a limitation of the sensor but a limitation of the test).

Conditions of initial tests:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Size of test pieces [cm²]</td>
<td>9</td>
</tr>
<tr>
<td>Static Pressure Test</td>
<td></td>
</tr>
<tr>
<td>Nº resistance measurements taken in 1 minute</td>
<td>110-150</td>
</tr>
<tr>
<td>Values were averaged?</td>
<td>yes</td>
</tr>
<tr>
<td>Applied Pressure [g*cm²]</td>
<td>2 - 555,6</td>
</tr>
<tr>
<td>Dynamic load test</td>
<td></td>
</tr>
<tr>
<td>Nº cycles</td>
<td>20</td>
</tr>
<tr>
<td>Measurements/second</td>
<td>50</td>
</tr>
</tbody>
</table>
## Table 3: Dynamic Sensor Response

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cycle Duration [s]</td>
<td>10</td>
</tr>
<tr>
<td>$T^*$ exposed to loading [s]</td>
<td>5</td>
</tr>
<tr>
<td>$T^*$ without loading [s]</td>
<td>5</td>
</tr>
<tr>
<td>Load [g]</td>
<td>500</td>
</tr>
</tbody>
</table>

3. Applications

The **Sensing Mat Platform** allows the development of products, which can determine X-Y positions on a thin, light, flexible, stretchable textile surface. The sensor also allows pressure level detection in various points on the surface of the material creating an X-Y-Z multi-touch sensor measuring pressure over a large surface area.

The sensing points within the sensor can be designed with different sizes, shapes and can also be positioned at any points within the textile surface. This flexibility allows **The Sensing Mat Platform** to be used in an infinite number of applications. It is the perfect ecosystem for your **Pressure Mapping applications**.

Some examples of possible applications observe below our Seating Mat Dev Kit, Mattress Mat Dev Kit and Fitness Mat Dev Kit:
The platform is suitable to be integrated in any part, to describe any 3D shape and to analyze different pressure patterns. These characteristics allow the possibility to integrate Pressure Sensor Tex in a high variety of different applications, as the following:
4. Pressure Mat Development Kit

We have a set of standard textile Dev Kits for testing and quick prototyping of products based on the Sensing Mat Platform. The Dev Kits include all the elements (Hardware and Software) to get familiar with the platform and identify the specifications required by the client to develop their specific product in later phases. All the Dev Kits include The Sensing Tex Customer Support to set the system up for the first time and a guidance throughout the process of testing the system in order to assure the client takes advantage of all the features of the Dev Kit to identify what is needed to customize it for their specific application.

The Pressure Mat Dev Kit is a general purpose platform product which allow you to collect analog pressure data from the sensing mats. The kit include two different size mats to provide a flexible configuration in order to fulfill any basic requirement of size and place for your application.

4.1. Pressure Mat Dev Kit. Sensing Mats features

This PST02 consists of a textile element having an 8x8 matrix style layout, 64 pressure sensor elements for testing and prototyping of Pressure Mapping applications.

### SENSING MAT CHARACTERISTICS

- **Textile Element:** Pressure Mapping Sensor.
- **Textile backing:** PES.
- **Overall Size:** 200x200 mm.
- **Number of Sensor Spot:** 64 sensors.
- **Matrix Sensor Size:** 160x160 mm.
- **Size of the Sensor Spot:** 10 mm diameter round shape.
- **Sensor Layout:** Matrix 8x8.
- **Resolution:** 20 mm from center to center.
- **Connector:** 16-way (two rows), 2.54mm pitch, flat connector.
the PST03 consists of a textile having a size of 360x360 mm with 256 sensitive elements matrix array of 320x320 mm. It integrates a flat, 16-way, 2.54 mm pitch, plug connection. This sensing mat allows the development of Pressure Mapping based products.

SENSING MAT CHARACTERISTICS

Textile Element: Pressure Mapping Sensor.  
Textile backing: PES.  
Overall Size: 400x400 mm.  
Number of Sensor Spots: 256 sensors.  
Matrix Sensor Size: 320x320 mm.  
Size of the Sensor Spot: 10 mm diameter round shape.  
Sensor Layout: Matrix 16x16.  
Resolution: 20 mm from center to center.  
Connector: 32-way (two rows), 2.54mm pitch, flat connector.

4.2. Pressure Mat Dev Kit. SDK 05

The 114 PST SDK 05 is an Electronic and Software Development Kit developed by Sensing Tex, a proposed compact cheaper solution for customers that incorporates all the major features of inputs, processing and outputs for Switch and Pressure Sensor Tex technologies.

A flexible architecture allows the PST SDK to use different sizes of PST matrix sensors, allowing the acquisition of pressure data, and the communication interface to computers or smartphones. Users can use the Bluetooth or USB ports in order to communicate the PST SDK with external devices, and then visualize the pressure maps with the Sensing Tex software. The following graph is an outline of the architecture.
MODULE CHARACTERISTICS

Hardware:
- Signal conditioning for PST sensors
- ARM® Cortex M4 96 MHz Microcontroller
- 32 I/O Channels that allows up to 16x16 matrix sensor
- USB PC Interface
- Bluetooth classic interface for Wireless Data Acquisition
- 12 bit resolution ADC
- Firmware upgrade circuit interface
- 500 mAh lithium polymer rechargeable battery
- Small Plastic Box (90x46x17 mm)

Software:
- It implements a proprietary Sensing Tex communication protocol
- Windows Demo Software
- Android PST Dev Kit app (available in the Play Store)
- API’s for Windows and Android

The SDK includes a Developer Guide for further information on how to take the maximum advantage of the Dev Kit, guiding the customer with:

- Technical Description of the SDK Board
- Control Protocol SDK Board
- Basic software SDK Windows
DEMO SOFTWARE WINDOWS

**Demo Software**
*Device disconnected*

**Demo Software**
*Device connected*
DEMO SOFTWARE ANDROID

Demo Software
Device disconnected

Demo Software
Device connected

Demo Software
Device connected
4.3. Pressure Mat Dev Kit. Services included

The Dev Kits are a complete working package to show all the feature of the Sensing Mat Platform by Sensing Tex. They are designed to be familiar with the platform and understand how it can be used to develop your products. Every Dev Kit includes the guidance of the Sensing Tex team in different ways:

- Initial set up: we guide you to set it up for the first time, calibrate the system and install the software elements in your devices.

- Customer Support: Our team is open to discuss about your expected application in order to identify the relevant features you can take advantage to design the specific requirements which will really provide value to your product before moving to a customized prototype.

5. Maintenance and Operating Instructions Dev Kits

The Dev Kits and all their elements are thought to be used in tests. That is why the connector is not protected in order to be connected to different devices, and we recommend no to wash the Samples and fold them carefully. Regarding customized solutions, we can develop products that can be washable and be fold in any possible way.

The following instructions apply only to standard elements:

**Sensing Mats**

- Sample Sensor Mats can be carefully fold and rolled up.
- Sample Sensor Mats can be cleaned with some soap and water with a tissue (please ask for washability, the connector is not protected).

More information included in the User Guide.

**PST SDK 05**

- Perform a correct battery charge in each use to achieve better long life battery.
- Never charge the SDK for more than an hour, it will decrease the battery capacity.
- Always turn OFF the SDK when it is going to be disconnected.
- Use 0.100" (2.54 mm) male double-sided header pins to connect the SDK and PST.
- Be careful when connecting or disconnecting the SDK with the sensor, because the pins may damage the fabric of PST.
6. Legal Note

Sensing Tex commercialized products which require a careful handling according to the provided instructions. Therefore, any manipulation, modification or transformation applied to Sensing Tex commercialized materials which do not match the standard existing protocols also given to the clients, or which are not strictly authorized by Sensing Tex, will cause an invalid existing product operation warranty, and Sensing Tex will not be responsible for any damage to the product or malfunction.

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