a sense for innovation IEE

High Dynamic Force Sensing Resistor - Insole

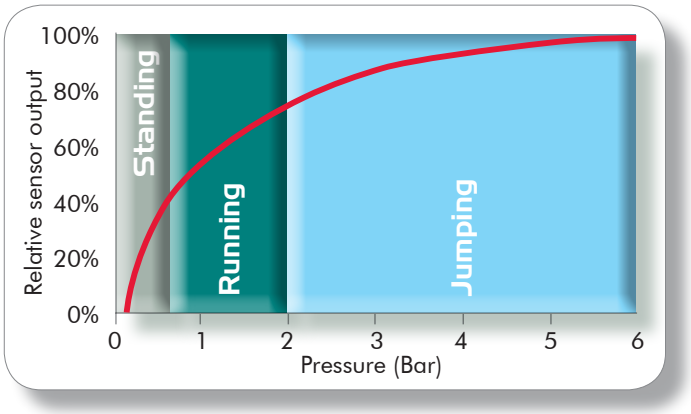
8-cell insole sensor - 5481

Key Features

IEE's high-dynamic FSR sensors are the newest generation of cells, and have an improved FSR cell performance. Several sensor cells can be combined in a number of variants.

Eight HD-FSR cells have been combined to form IEE's thin, flexible, 8 sensor cell insole, specifically designed for in-shoe pressure measurement applications. The insole is able to measure punctual plantar pressure of up to 7 bar beneath the foot's heel, midfoot, metatarsal heads, and the toes.

HD-FSR sensors have been adapted for a range of uses where high sensor dynamic over a wide pressure range (from 250 mbar up to 7 bar) is required. The staggering of individual cell segments allows us to create a homogeneous repeatable cell response along the axis of staggering.



With the help of a standard printed fixed resistor you can also compensate variation, due to environmental influences, on the cell output.

Technology

HD-FSR incorporates the FSR pressure detecting technology with an individual triangular cell segmentation. This allows you to measure a change in resistance over a wide pressure range (from 250 mbar to 7 bar).

Each triangular segment can be seen as an independent, fully-functioning part of the whole cell. This allows a high degree of design freedom and segment interconnection.

Our HD-FSR sensors:

- Have an actuation force as low as 250 mbar
- Have a sensitivity range of up to 7 bar
- Are robust; up to 1 M actuations under highest humidity conditions (lifetime variation < 15%)
- Can be used in a slightly bent position
- Can be individually calibrated using a three-point interpolation of the pressure response curve
- Have a very low hysteresis compared with our standard sensors

With IEE's foil-type contact technology, we can create slim, pressure-activated sensors. The shape of each sensor can be adapted to suit numerous geometrical environments, and different sensor segment interconnections can be combined in one device.

Sensor Configurations

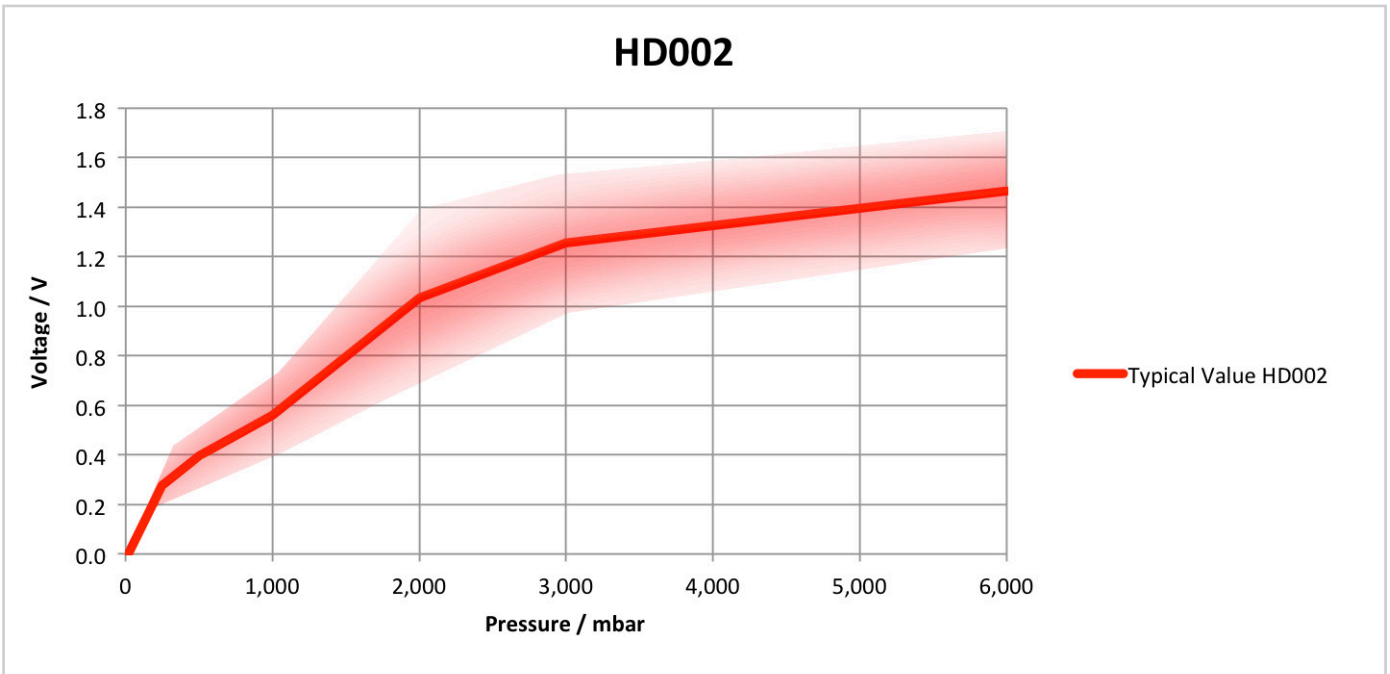
High Dynamic Force Sensing Resistor (HD-FSR) - Single Cell

Cell dimensions of the HD-FSR (HD 002) sensor:

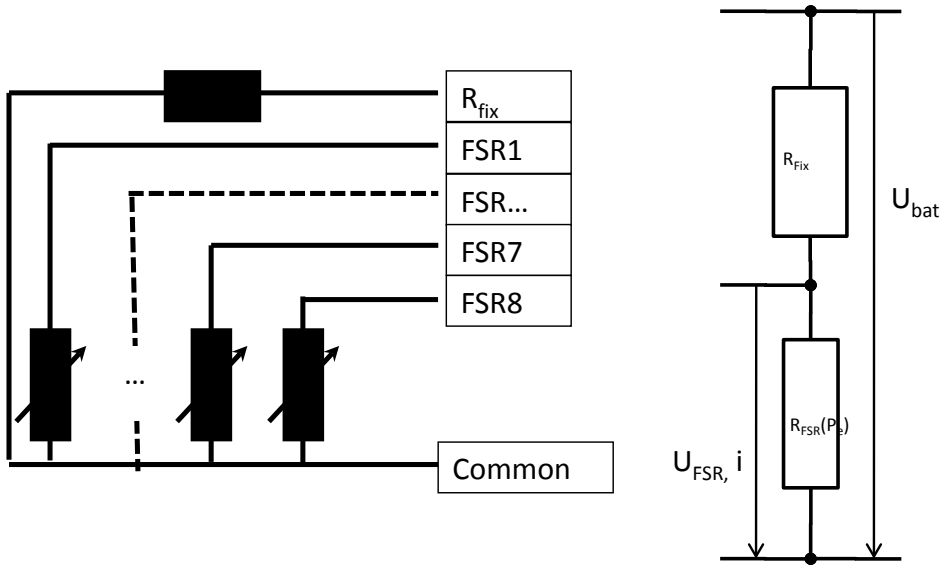
Sensor Type	Detection Area Dimension	Pressure Load	Rfix	Typical Resistance Value	Typical Value in Voltage Divider
HD 002	rectangular, 31 x 14.75 mm	500 mbar 2,000 mbar	2 kΩ < Rfix < 4 kΩ	9 kΩ < RL < 45 kΩ 2 kΩ < RL < 15 kΩ	0.26 V < Vfsr < 0.53 V 0.67 V < Vfsr < 1.40 V

Typical Response Curve

The typical response curve of a singl HD-FSR cell is based on the sensor equivalent circuit with a 3 V supply voltage (UBAT). The measurement voltage (UM) is shown in dependency of the applied pressure on the sensor cell. Here the sensor cell is placed on a steel plate with the overpressure applied by a latex membrane bladder from the top.



Simplified Sensor Equivalent Circuit - 8-cell insole

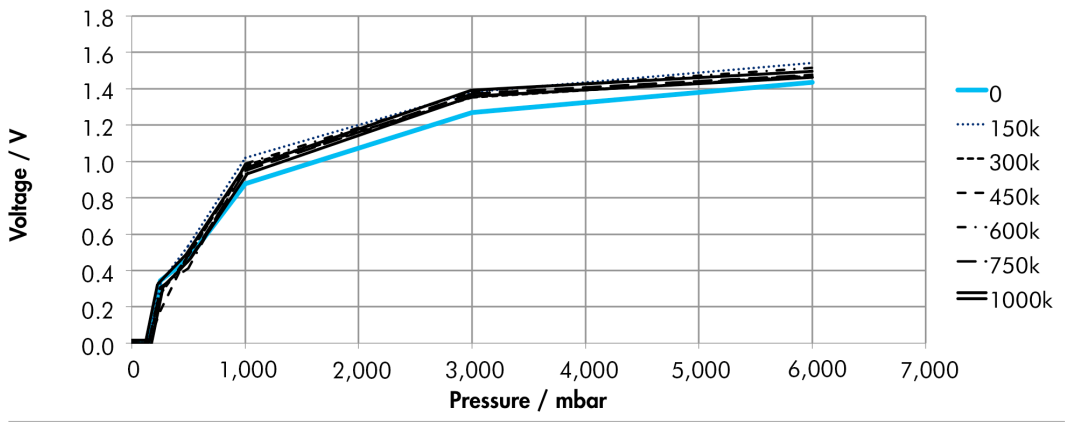


$$U_{FSR,\,I}\,(p) = U_{bat} * R_{FSR,I}\,(p) \,/\, (R_{fix} + R_{FSR,I}\,(p)\,);$$

$R_{FSR,I}\,(P)$	*Sensor resistance*
R_{FIX}	*Resistance of printed fixed resistor*
UBAT	*Supply Voltage (Typical 3V)*
$U_{FSR,I}\,(P)$	*Measurement Voltage*

Typical Sensor Robustness

The typical cell response during its life-time under the described conditions (1,000,000 cycles @ 7 bar, 1 Hz and 95% r.H.) is shown below:



Typically, you should mount the FSR sensors onto an even and smooth support surface, we recommend to mount the 8-cell-insole on or between rubber or foam layers.

- To avoid mechanical pre-load and false signals, do not bend the insole in the active area to a radius of < 120 mm.
- To avoid broken conductor lines, do not bend the insole on the connection tail to a radius of < 5 mm.
- All sensors feature an air vent. Take care not to block it and to avoid liquids from penetrating through it.

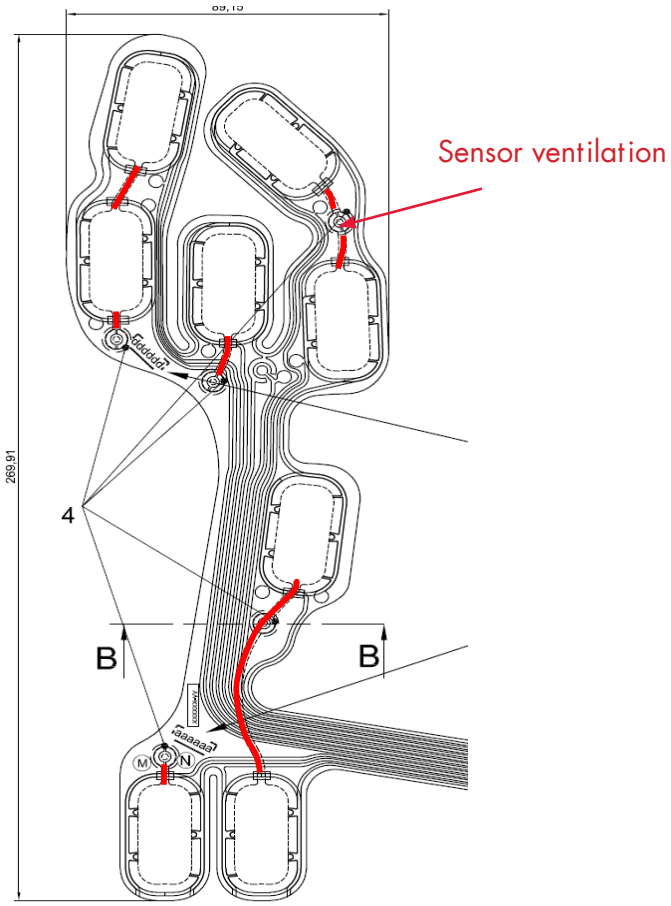
The insole sensors can be read out with or without calibration, depending on the type of use and the accuracy required:

- To avoid additional process costs for individual cell calibration, all sensors can be read out without calibration by using the typical response curves shown on page 3. This may be useful if you have a high-volume market.
- To ensure high sensor accuracy and repeatability, all sensors can be calibrated by three-point pressure response curve interpolation. Thanks to the very high environmental and mechanical robustness of the new HD sensor, no recalibration is needed during the sensor's lifetime.

The sensor shows a very low hysteresis in the pressure response curve.

- Hysteresis for HD 002: 8%

This is a significant advantage for applications like gait analysis, where the pressure changes need to be monitored in a high frequency (e.g. monitoring of movements, impacts).



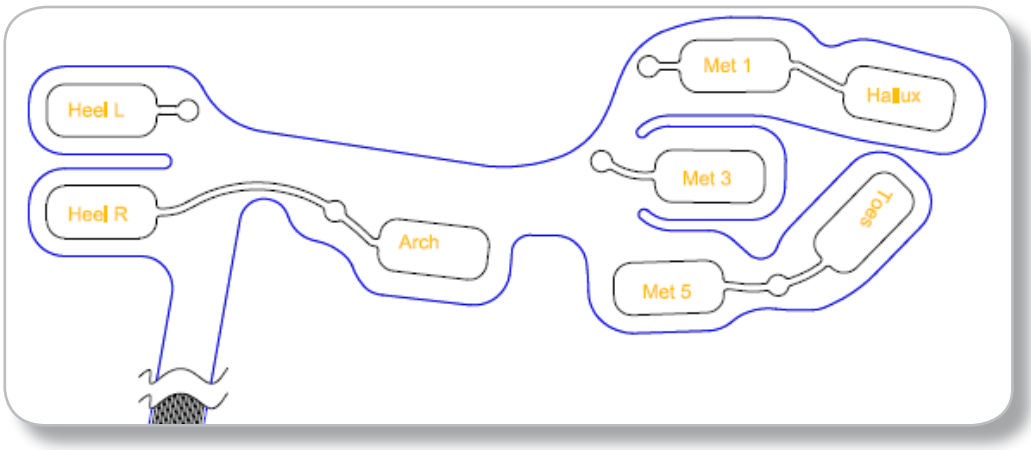
Sensor Characteristics

Sensor Description	
Sensor type	Pressure Sensitive 8-cell-insole
Typical applications/devices	Dynamic user interface devices and high-dynamic pressure sensors for in-shoe measurements
Number of active areas/cells	8
Dimensions and available connectors	See layout drawings on the following pages
Manufacturing Tolerances	
Length and width tolerances	According to DIN 7151 IT 14
Thickness	Nominal value +/- 12 %
Total manufacturing tolerance	+/- 0.8 mm
Base Materials	
Topside substrate	PET film
Laminating adhesive	Acrylic
Backside substrate	PET film
Backing adhesive	Acrylic
Operating Parameters	
Standby resistance (no load)	RNL > 1 MΩ (between pin 3,5,6,7,8,11,12,13 and COM)
Typical activation resistance range for a pressure range of	1 MΩ > RL > 2 kΩ 250 mbar - 7 bar. See Typical Response Curve on page 3
Typical conductor lead resistance	≤ 25 Ω
Typical lifetime when used according to application advice	> 1,000,000 cycles @ 7 bar, 1 Hz and 95% r.H.
Typical sensor response time on single activation	2 - 3 ms (mechanical)
Current density	< 1 mA/cm² (of activated area)
Parasitic capacitance	< 1 nF
Power dissipation	< 1 mW/cm² (of activated area)
Operating Conditions	
Nominal operating voltage	3V according to simplified sensor equivalent circuit
Operating temperature range	-40 to +85 °C (-40 to 185 °F)
Operating humidity range	≤ 95 % R.H.
Standard Test Criteria at Time of Delivery	
Standby resistance	RNL > 1 MΩ @ RT
Measuring device	IEE overpressure membrane tester

8-cell Insole Pinout

Pin	Position
1	NOT CONNECTED
2	NOT CONNECTED
3	HEEL R
4	COM 1
5	HEEL L
6	MET 1
7	HALLUX
8	MET 3
9	COM 2
10	RFIX
11	TOES
12	MEET 5
13	ARCH
14	NOT CONNECTED
15	NOT CONNECTED

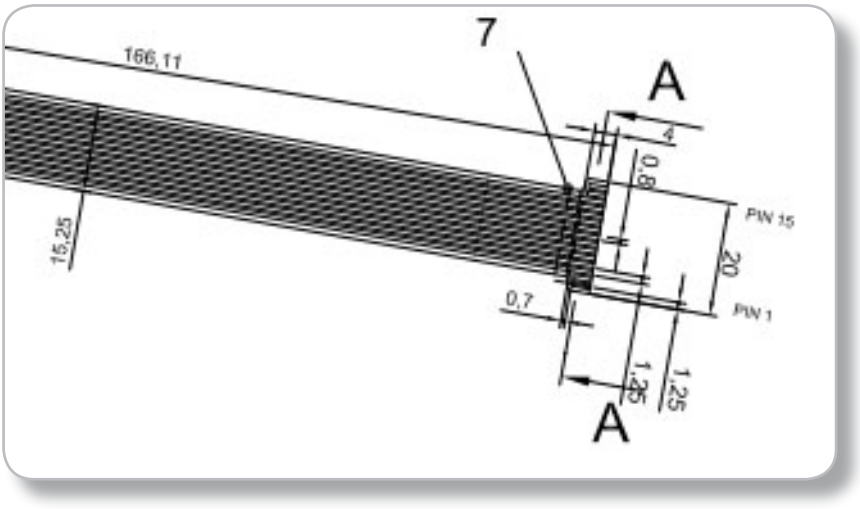
- *COM 1 and COM 2 should be connected on the electronics board*
- *R_{Fix} is located between pin 9 and pin 10*



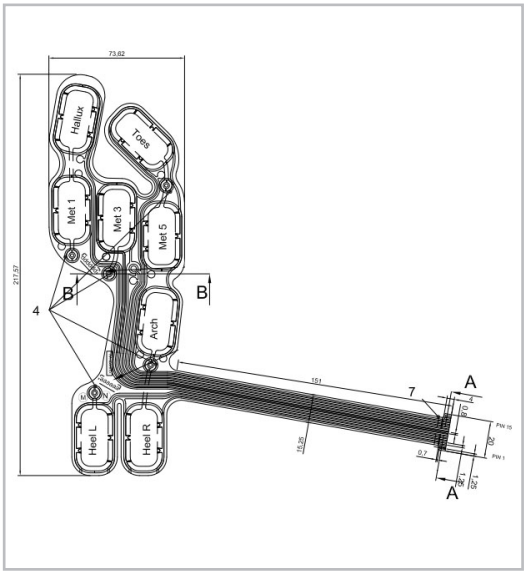
Dimensions of Connector Tail

The 8-cell insoles are prepared for the use of a 15 pin FFC-ZIF connector. (Pitch 1,25mm)

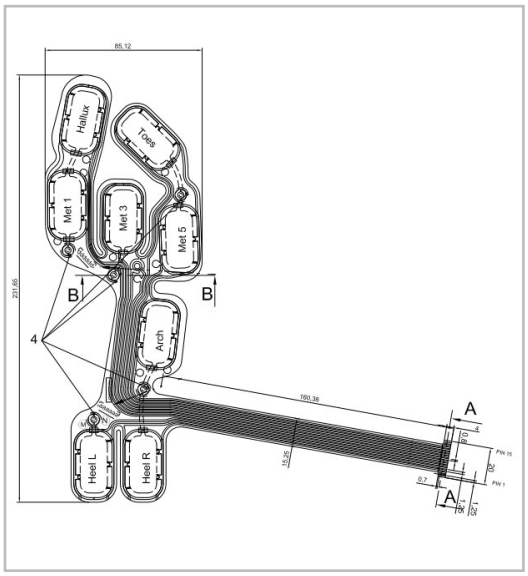
The same insole design can be used in the left and right shoe by turning it upside-down. A double sided ZIF may be used.
The mechanical fixation of the ZIF connector may be secured by a piece of shrinkage tube.



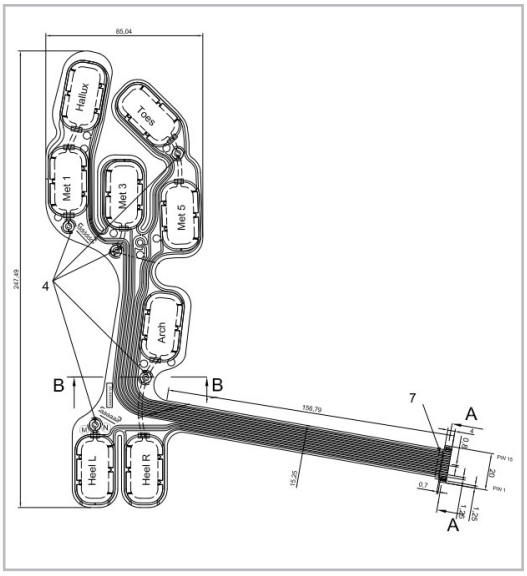
8-cell Insole Sizes



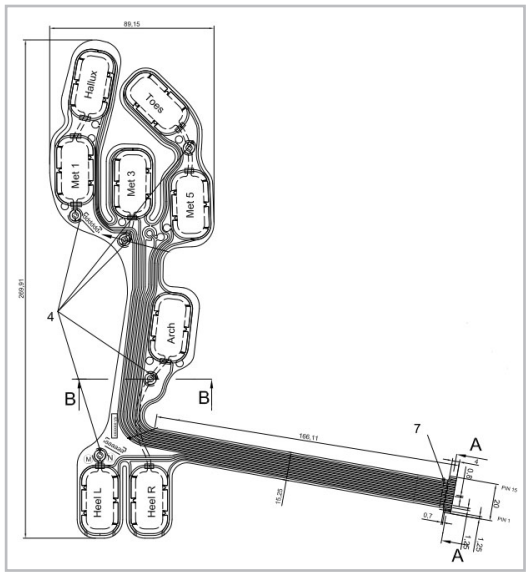
Size S: 217,57 x 73,82mm



Size M: 231,85 x 85,12mm



Size L: 247,49 x 85,04mm



Size XL: 269,91 x 89,15mm

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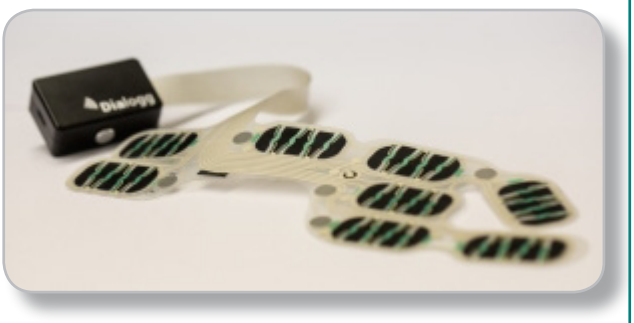
ENVISIBLE®

Datalogging and Communication - this is Dialogg.

In collaboration with IEE we are now offering the Smart Foot Sensor Development Kit. Dialogg is a pocket-sized biomechanics lab! It provides you with dynamic monitoring of plantar foot pressure and 6 DOF inertial sensor information. The system easily communicates with mobile devices or PCs for real-time feedback and enables you to store hundreds of hours of measured data. The highly accurate Foot Sensor is perfectly suited to be integrated in any kind of footwear - or just can be used right out-of-the-box.

Further extensions and modifications are available on request. We ENable you to see the inVISIBLE



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DS-8-cell-insole-2016-12-21-EN

Contact

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- Surf to www.iee.lu