OpenGo *science*

SENSING FOOT DYNAMICS

Product name

OpenGo science

Document name

Booklet

Technical specification and other information on OpenGo *science* products.

Booklet version

- Release: 01.00.07
- Date: August 7th, 2014

All information is subject to change

Symbols

+ Add-on

Content	Page

OpenGo *science*

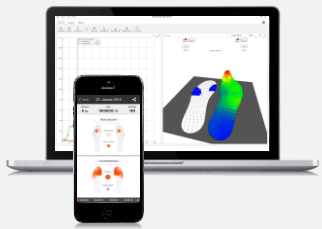
SYSTEM OVERVIEW

OpenGo *science* components overview

Sensor insoles

Accessories

Software or app



Starting with an **OpenGo *science*** system is easy.

You basically need **sensor insoles** and our high performance analysis software **Beaker**.

Look at our Products and Support web pages for more information and system configuration!

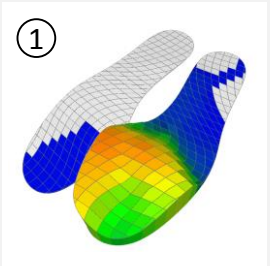
OpenGo sensor insole

The core of **OpenGo** ***science*** is the world‘s first fully integrated **sensor insole**, made by Moticon.

It measures the **plantar pressure distribution, total loads** and the **acceleration** of the foot.

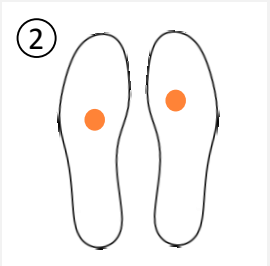
The sensor insole is **completely wireless** and hence does not interfere the wearer‘s motion in any way.

Sensor insole measurement data



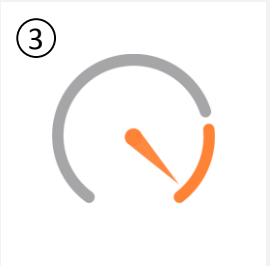
Pressure distribution

Distribution of mechanical stress on the insole area which can for instance be displayed as a color pattern.



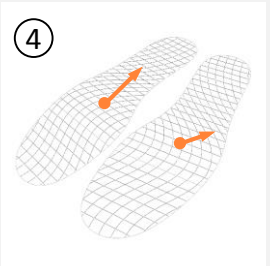
Center of pressure

One single point that represents the focus of the mechanical stress at a certain point in time.



Total force

Load F (in Newton) that results from summing up the value of all pressure sensors.



Acceleration

Acceleration is a measure for the change of velocity of a body per time. It indicates movement characteristics and can be displayed as a vector.

Some sensor data is measured directly by the sensor insole (1, 4), others can be calculated based on the sensor insole data (2 and 3).

Moticon software: OpenGo = open interfaces

Firmware „Nurmi“

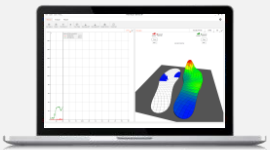
Sensor insole operating system

Moticon API

Middleware, open interfaces (Python)

Analysis software „Beaker“

Measurement control, data analysis, im/export



Mobile app „Bunsen“

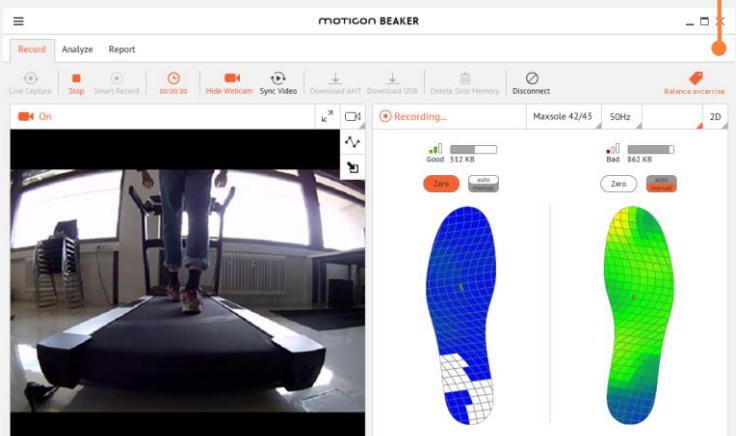
Measurement control

Customer software

Integration into proprietary systems

Analysis software Beaker

Screenshot Beaker



Beaker is a powerful data **analysis software**.

Its functionality comprises acquisition of sensor insole data and external data (EMG, heart rate, force plate etc.), automated video sync, standard gait analysis functions, comparisons functions, marker based reporting and many more.

Look at our Products and Support web pages for more information!

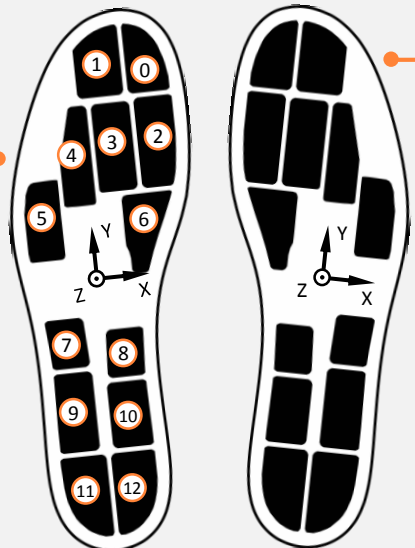
OpenGo sensor insole

SENSOR SPECIFICATIONS

Pressure sensor specifications

Pressure sensor numbering

Inertial system



Pressure sensor layout

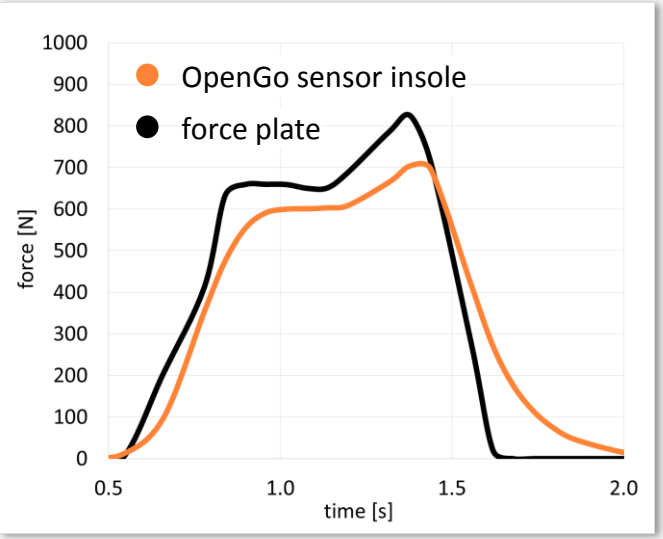
Note: The sensor insole outlines, the sensor outlines and the sensor centroids can be retrieved from the OpenGo science API, if needed.

Basic pressure sensor specifications

Principle	capacitive
Quantity	13 per sensor insole
Coverage	~ 50 %
Range	0.0 – 40.0 N/cm²
Sensitivity	0.25 N/cm²
Output resolution	7 bit
Sampling frequency	5, 10, 25, 50, 100 Hz

Dynamic pressure sensor accuracy

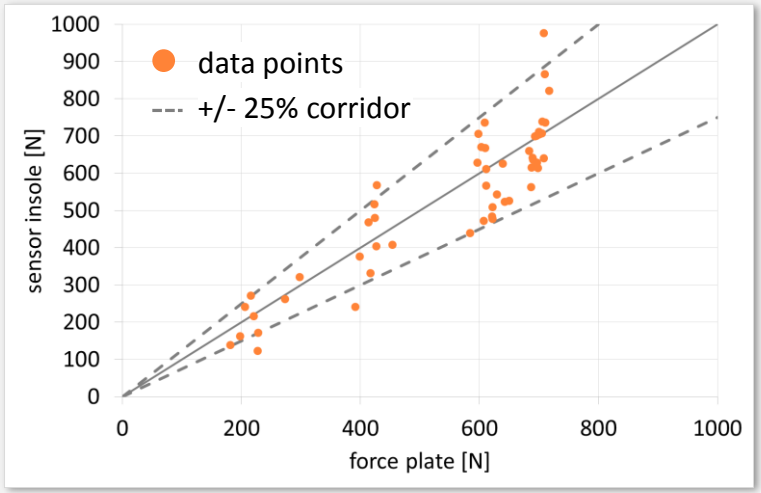
Note: The graph shows the typical outcome of a gait step. The measurement which was taken from a walk over a force plate with a walking speed of ~ 2.5 km/h over flat ground.



Dynamic response behavior

Gold standard	AMTI ForcePlate BP6001200
Correlation coefficient	0.97 (Pearson)
Sample size (steps)	N = 1
Characteristics	• Good initial response behavoir • +/- 25 % deviance of max. loads • Some delay in load removal

Pressure sensor reliability



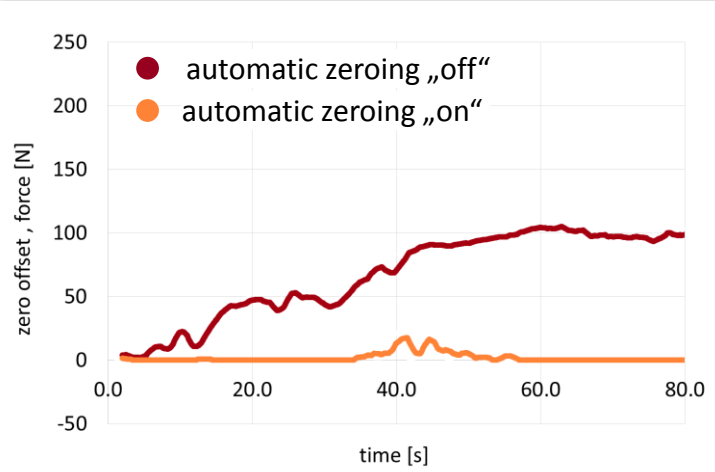
Note: The graph shows the maximum load correlation of different standardized motion patterns between a force plate and the sensor insole, related to a corridor of precision.

Precision of load measurements

Correlation	92.5 % data points in corridor
Sample size	N = 50
Moticon patterns	• Partial weightbearing steps (20 kg ≤ L ≤ body weight) • Walking steps (slow, normal, fast, very fast)

Pressure sensor zero offset compensation

Note: The graph shows typical outcomes of different zeroing methods for pressure sensor zero offsets during a 400 m track run measurement. The sensor insoles were not preheated.

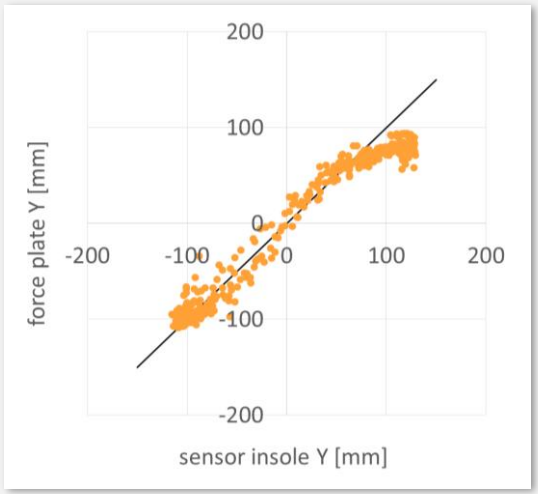


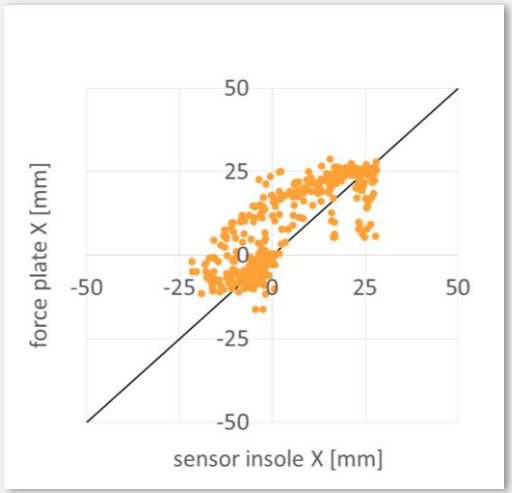
Offset compensation mechanisms

For zeroing offsets, 3 methods can be used.

1. **Zero** – to zeroize initial preloads manually.
2. **Auto off** – for static or short dynamic measurements. Sensor drifts are not compensated.
3. **Auto on** – for longterm measurements. Sensor drifts are automatically and continuously zeroed.

Center of pressure from pressure distribution





COP precision

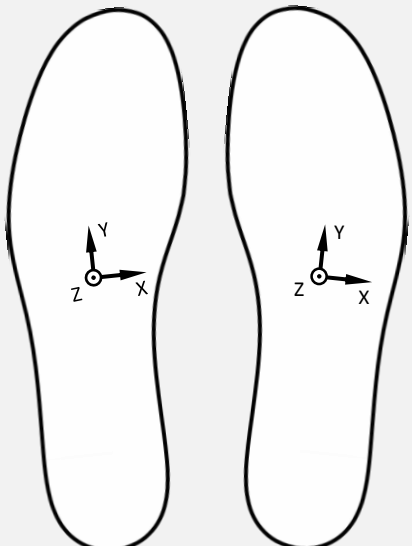
Correlation coefficients (Pearson)

X = 0.80
Y = 0.98

Sample size N = 356

Acceleration sensor specifications

Inertial system & acceleration sensor position



Note: The acceleration sensor is used for the sensor insole control (internally) and for the generation of motion data for analysis purposes.

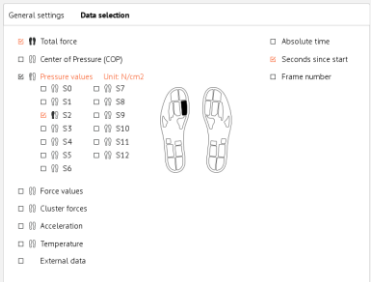
Basic acceleration sensor specification

Principle	inertia mass
Quantity	1 per sensor insole
Type	triaxial XYZ (MEMS)
Range	± 2, 4, 8 g
Position	midfoot (see ←)
Output resolution	7 bit
Sampling frequency	5, 10, 25, 50, 100 Hz

Sensor data syntax and data format

data export

configuration screen



Note: Sensor clusters can be defined in the configuration screen.

For external data processing, the sensor insole data can be **exported in general ASCII format** style from the Beaker analysis software.

Sensor values

p pressure

ax, ay, az
accleration

All parameters for left and right sensor insole.

Processed values

cx, cy	center of pressure
l	total force
f	single sensor force

All parameters for left and right sensor insole.

Sensor value organisation

In total, the sensor insole produces 16 sensor values, 13 x pressure and 3 x acceleration.

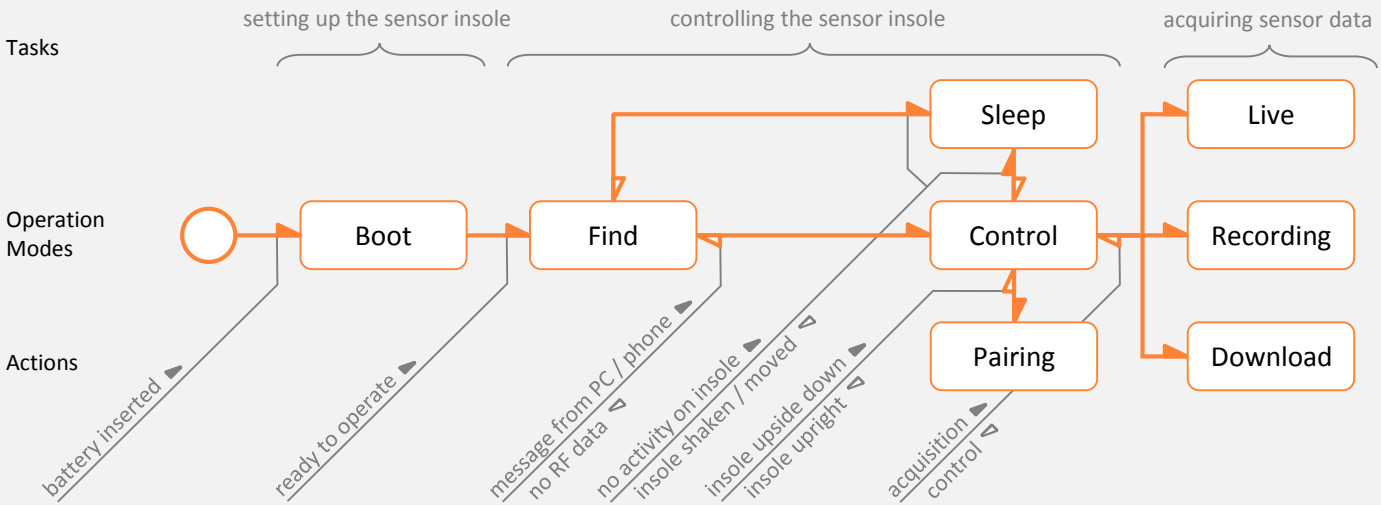
For convenient data analysis, other important parameters are processed directly by the API (←).

Both parameter sets and timing information can be exported to ASCII format matrix style text files.

OpenGo *science*

SENSOR INSOLE OPERATION & CAPABILITIES

OpenGo sensor insole operating system modes



Setting up the sensor insole

Boot

Quiescense

If no coin cell is inserted, previously **recorded sensor data retains** on the internal memory.

Also, **calibration** and **ID** are kept non-volatile.

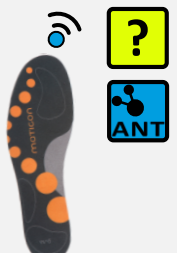
Starting up

Inserting a coin cell causes the firmware to **Boot** and switches to **Find**. The firmware can be updated via ANT.

t(boot) = 7 sec.

Controlling the sensor insole

Find



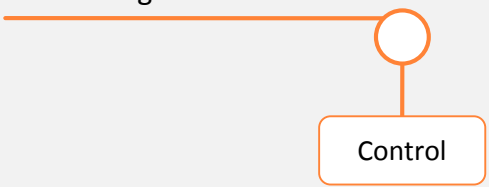
Finding clients

Find opens ANT radio channels and sends request messages at a low message rate.

When a client (PC or phone) is found, Find closes and switches to **Control**.

OpenGo sensor insole operation mode description

Controlling the sensor insole



Switching between operation modes

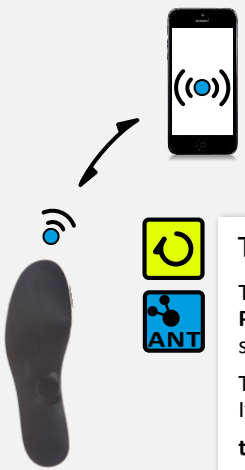
In **Control**, a sensor insole is connected to a client and ready to receive control messages.

In this mode, it continuously sends **status data** (table →). It can either be turned to **Recording**, **Live, Pairing, Sleep** or **Download**. If the radio link to the client breaks down, it switches back to **Find**.

Status data	Specification / syntax
InsoleID	unique sensor insole ID
Version	version of the sensor insole firmware
SN	serial number of the sensor insole
Restarts	number of battery changes (hardware restarts)
System Clock	time since last battery change (including sleep)
Uptime	active time since last battery change
Op time	overall operation time (endures battery changes)

Controlling the sensor insole

- Pairing
- Sleep



Tying sensor insoles and clients

Turning a sensor insole upside down switches it to **Pairing**. A client also in Pairing can find an unknown sensor insole, connect to it and gather status data.

Turning the sensor insole back returns it to **Control**. If no radio link is established, it returns to **Sleep**.

$t_{(upside\text{-}down)} > 5$ sec., $t_{(no\ radio\ to\ sleep)} > 10$ sec.

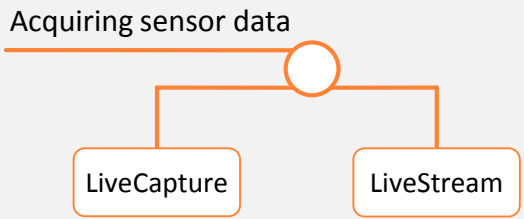
Saving energy

If a powered-up sensor insole does not receive messages from a client or is not moved, it turns to **Sleep**. Sleep is a low power mode to save energy.

Shaking wakes it up and swaps to **Find**.

$t_{(no\ action\ to\ sleep)} = 60$ sec., $t_{(shake)} = 1$ sec.

OpenGo sensor insole operation mode description



Life is live !

Live is the basic operation mode for sensor data acquisition. Data is streamed wirelessly and in realtime to an ANT enabled PC or other client.

The data can be stored as a **LiveCapture** or used as a **LiveStream** to generate realtime feedback.

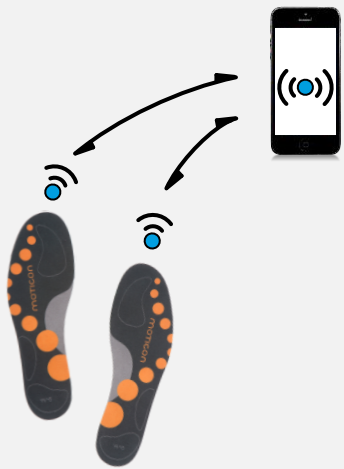
Live and Recording cannot be used simultaneously!

Specifications

Sensor sample rates
5, 10, 25, 50 Hz

ANT latency
0.18 s

Range
2 – 5 m



Acquiring sensor data

⊕ Add-on capability!

Recording

Absolute mobility !

Recording enables your sensor insoles to store sensor data directly on the integrated memory (table ↗).

Your data acquisition becomes fully independent of external devices and the range of action extends endlessly.

Specifications

Sensor sample rates
5, 10, 25, 50,
100 Hz (8 sensors)

Memory size
16 MByte (128 MBit)

Synchronization none

Sample rate (Hz)	Recording (hh:mm:ss)	Note (see explanation below!)
100	05:48:00	8 sensor values
50	05:48:00	16 sensor values
25	11:46:00	16 sensor values
10	≤ 59:00:00	16 s.v. (48 h) or special setup
5	48:00:00	16 sensor values

Note: In total, the sensor insoles produces 16 sensor values in the full measurement setup (13 x pressure, 3 x acceleration).
For measurements with 100 Hz, any combination of 8 sensor values can be configured for a reduced setup, see p. 16.
The special setup for 10 Hz comprises a sensor clustering (4 clusters) and the COP value.

OpenGo sensor insole operation mode description

Acquiring sensor data

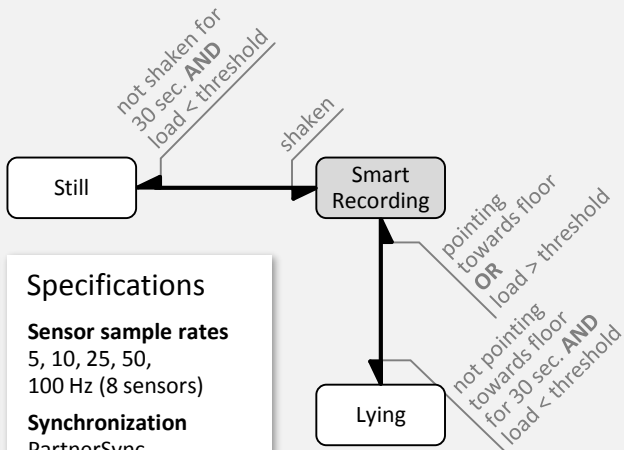
⊕ Add-on capability!

Smart Recording

Be smart, measure smart !

SmartRecording is an intelligent recording mode for longterm **measurements up to 4 weeks**.

It is **event driven** (diagram ↗) and triggers **Recording** only if loads acts on a sensor insole.
To keep the sensor insoles **synchronized by time,** they exchange time sync signals (**PartnerSync**).

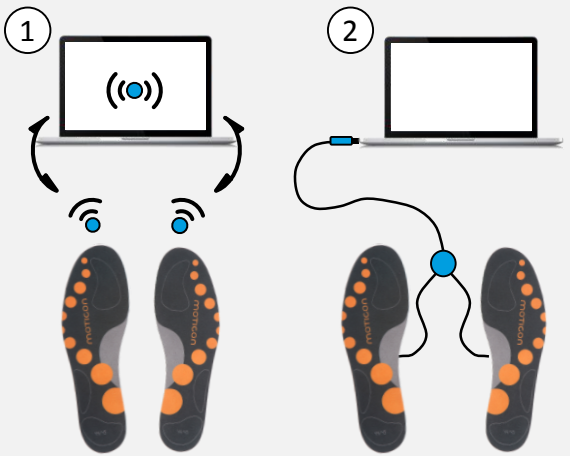


Specifications

Sensor sample rates
5, 10, 25, 50,
100 Hz (8 sensors)

Synchronization
PartnerSync

$t_{(sync)}$ = 60 min.



Acquiring sensor data

⊕ Add-on capability!

- ANT Download
- USB Download

Downloading data

In order to download any recorded data from sensor insoles, **Download** enables a wireless **ANT Download** (1).

To accelerate data transfer, use **USB Download** (2). A special download cable plugs into the battery compartments of both sensor insoles.

Specifications

Download time/pair
for full 16 Mbyte mem.

ANT 5:40 h
USB 0:14 h

Connector PC side
USB A-type

OpenGo sensor insole capability summary

⊕ Add-on capabilities!

Basic

1 pair of sensor insoles comes along with ANT wireless for **LiveCapture** and **LiveStream** as well as **ANT-Download**.

→ see pp 22 and 25

Recording

Recording allows storing data directly on the sensor insoles.

The capability is per pair!

→ see p. 23

SmartRecording

SmartRecording allows event driven recording to save memory space.

The capability is per pair!

→ see p. 24

USB-Download

USB-Download speeds up the data download from the internal mem.

The capability is per pair!

→ see p. 25

OpenGo *science*

SENSOR INSOLE SIZES

OpenGo sensor insole sizes

Moticon	EU	US	UK
1	36 / 37	4 ½ / 5	3 ½ / 4
2	38 / 39	6 / 6 ½	5 / 5 ½
3	40 / 41	8	7
4	42 / 43	9 ½	8 ½
5	44 / 45	11 / 11 ½	10

Shape figures information

Scale = 1:4

Unit: mm

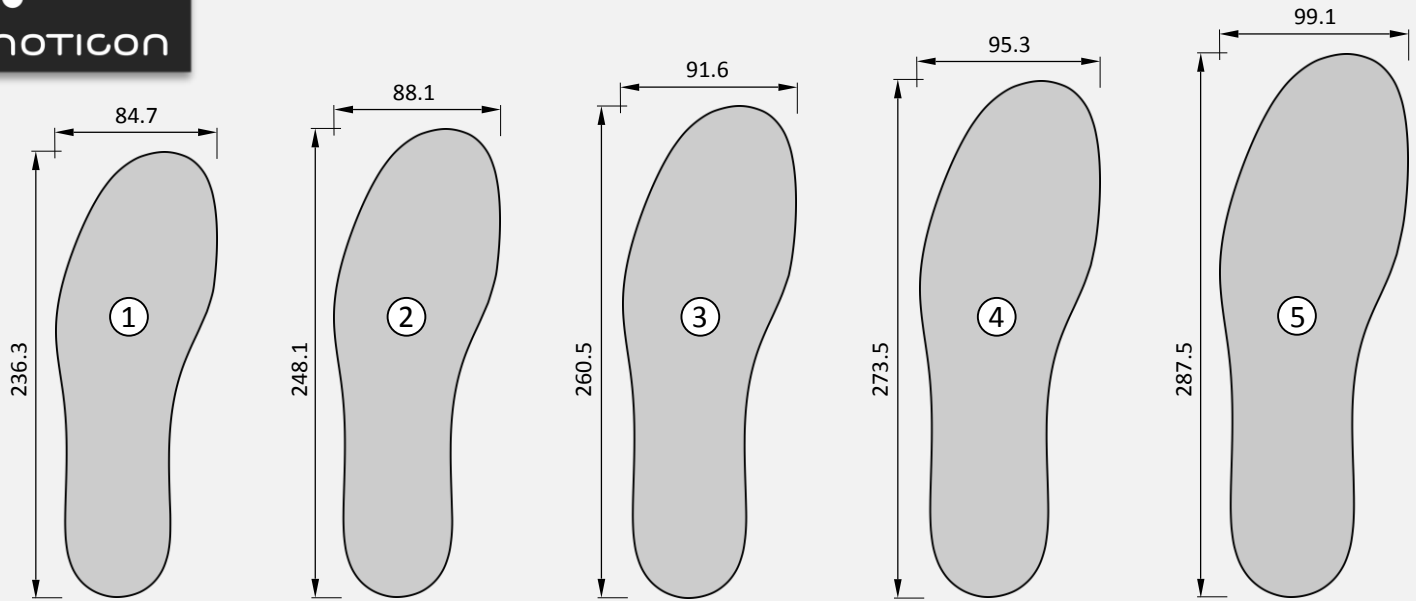
Width: medium [m]

Sizing information

Sizes
5 double sizes [1…5]

Dimensions relate to sensor insole.

Sizes relate to shoe sizes.


84.7
236.3
1
88.1
248.1
2
91.6
260.5
3
95.3
273.5
4
99.1
287.5
5

MOTICON

OpenGo *science*

SENSOR INSOLE POWER SUPPLY & HANDLING

Power supply

Coin cell charger

Coin cells

Coin cell	
Model	PD2032
Type	rechargeable
Voltage	3.7 V
Capacity	75 mAh
Cycles	400 (70 %)

Coin cell charger	
Model	wall adapter or other
Type	CC / CV
Charge voltage	4.2 V

OpenGo sensor insoles should exclusively be operated with **rechargeable coin cells** !

Primary coin cells (batteries) may cause mal-function due to a much faster voltage drop !

You need 1 coin cell model PD2032 for each sensor insole.

To make it simple:
the intended use of the OpenGo sensor insole is **inshoe measurement**.

Many different shoe types may be used, but **DO NOT use** the sensor insoles for measurements **outside a shoe !**

Sensor insole handling instructions

NO !!

Do not cut

Cutting the sensor insole will inevitably damage its sensors.

Do not intend to fit by cutting!

NO !!

Do not stitch

Sharp elements cause severe damage in the electronics and sensors of the sensor insole.

Take care of spiky objects!

NO !!

Do not bend

The sensor insoles are made for inshoe measurements.

Atypical bending destroys the electronics and sensors!

NO !!

Do not tort

The sensor insoles are made for inshoe use cases.

Atypical tortion destroys the electronics and sensors!

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