
OpenGo by MOTICON

# Sensor Insole Specification

PRELIMINARY

Effective September 1st, 2021

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# Overview

**Model**
Insole3


Moticon's *OpenGo Sensor Insole* is a versatile tool for sensing human foot dynamics.

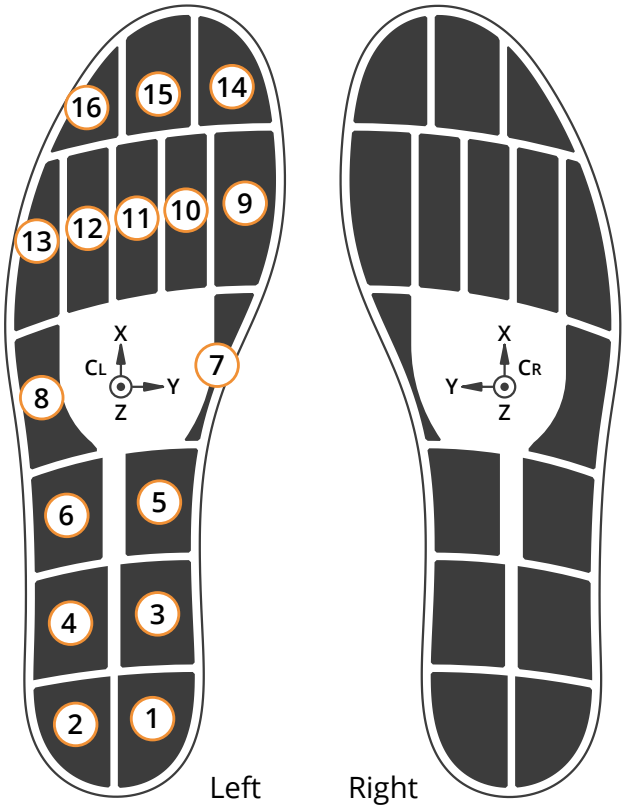
The sensor insole is fully integrated and highly flexible. It incoporates all technological components to execute standalone measurements. No external devices are required for data acquisition.

The following table depicts the basic specifications. For more detailed information, refer to the corresponding chapters of this document.

| | |
|---|---|
| Sensors | 16 pressure  3 acceleration  3 angular rate  per side |
| Wireless | Bluetooth Low Energy |
| Power Supply | PD2032 coin cell battery, rechargeable |
| Sizes | 9 double sizes  EU 32/33 - 48/49  US 1/2 - 12½/13½ |
| Data Storage | On-board memory & live transmission to smartphone |

# Pressure Sensors

| Quantity | Type | Axis | Range | Resolution | Hysteresis | Calibration |
|---|---|---|---|---|---|---|
| 16<br>per side | capacitive<br>plantar | Z | 0-50 N/cm² | 0.25 N/cm² | ≤ 1 % | in-production<br>lifetime |




**Notes**

The sensor insole outline and the sensor positions are given in a common coordinate system.
The orientation of the coordinate systems is different for left and right sides.

**Legend**

(1) Sensor numbering
X / Y / Z Directions of coordinate system
$C_{L/R}$ Center of coordinate system

# Pressure Sensor Geometry

| | Size 1 | Size 2 | Size 3 | Size 4 | Size 5 | Size 6 | Size 7 | Size 8 | Size 9 | |
|---|---|---|---|---|---|---|---|---|---|---|
| **TAI** | 12,129 | 13,240 | 14,462 | 15,787 | 17,237 | 18,824 | 20,572 | 22,456 | 24,524 | $mm^2$ |
| **TAS** | 7,578 | 8,330 | 9,179 | 10,109 | 11,129 | 12,241 | 13,696 | 15,042 | 16,525 | $mm^2$ |
| **SC**[1] | 62.5 | 62.9 | 63.5 | 64.0 | 64.6 | 65.0 | 66.6 | 67.0 | 67.4 | % |

**Notes**

[1] Sensor coverage varies over size due to keepout areas for wiring, electronics, antenna and borders which do not scale with size.

**Legend**

TAI: Total area of sensor insole.
TAS: Total area covered by pressure sensors.
SC: Sensor coverage. Area covered by pressure sensors in relation to total area of sensor insole.

# Pressure Sensor Calibration

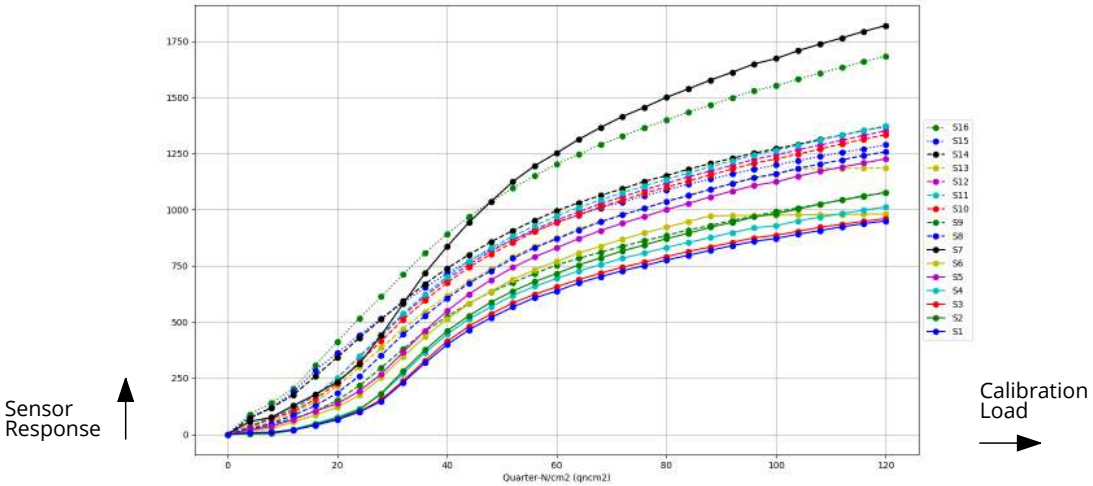
| Type | Device | Procedure |
|---|---|---|
| in-production testing (IPT) | fluid cushion | each sensor insole is calibrated individually |
| user calibration | n/a | user to carry out motion sequence to calibrate sensor insole individually for highest accuracy [1] |

**Notes**

[1] The calibration routine is carried out using the *OpenGo App*. Visit moticon.com/doc-opengo-calibration for more information.

**Example**

The figure shows a typical stack of calibration curves as generated in the in-production testing, representing the pressure sensor response function when loaded. Each calibration curve relates to one discrete pressure sensor.



# Pressure Sensor Zeroing

| Type | Description |
|---|---|
| automatic zeroing mode [1] | offsets and drifts in the pressure sensor readings are compensated automatically by software routines. |
| manual zeroing [2] | manual zeroing of pressure sensor readings. |

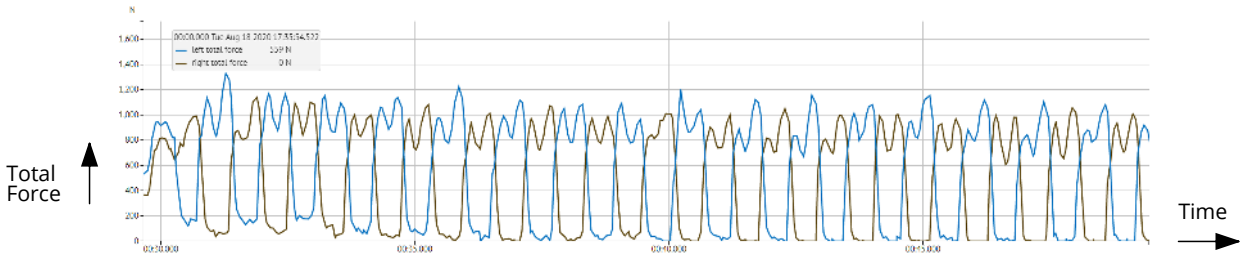
**Notes**

[1] The automatic zeroing mode is always active. It is based on algorithms continuously checking sensor zero levels and compensates for sensor offsets and drifts which may occur due to lacing shoes and due to temperature changes.

[2] In addition, a manual zeroing routine can be carried out by means of a software function in the *OpenGo App*.
The routine does not disable the automatic zeroing, but overwrites current zero values. The routine should be applied in cases where no unloading cycles occur or are not feasible before measurement start.

**Example**

The following example shows the effect of the automatic zeroing mode.
The graph shows the total force readings of the left (blue) and right (brown) leg of a normal gait.
After 2-5 steps of walking, initial offsets are compensated to a level between 0N and 5N which is caused by sensor noise only.



# Acceleration Sensors

| Quantity | Type | Axis | Range | Resolution | Hysteresis | Calibration |
|---|---|---|---|---|---|---|
| 1<br>per side | MEMS<br>LSM6DSL | X/Y/Z | ±16 g | 0.488 mg/LSB<br>16 bit | n.a. | in-factory<br>lifetime |

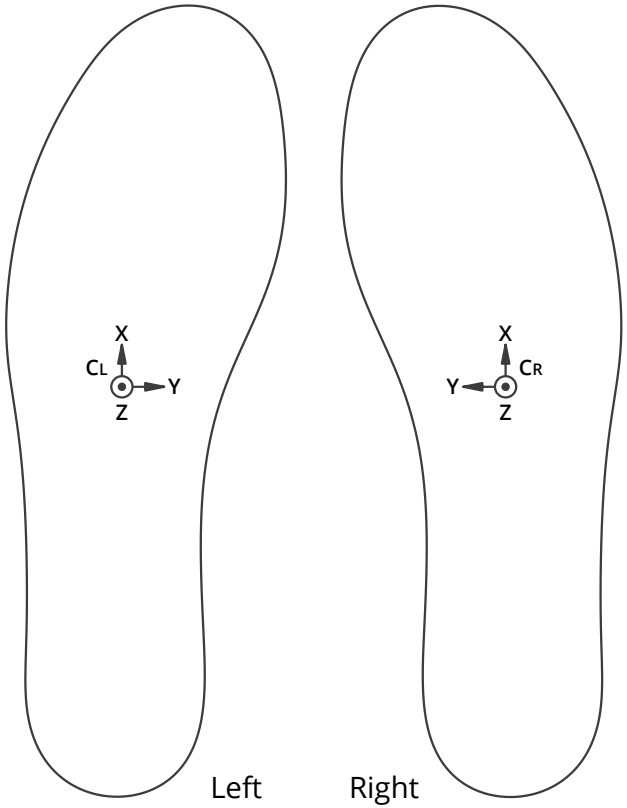
**Notes**

The position of the IMU sensor is at the origin of the coordinate system.
The orientation of the coordinate system is different for left and right sides.
Any coordinates to the sensor centers and outline coordinates of the data output are given in relation to the coordinate system.

Refer to the official LSM6DSL ST Microelectronics datasheet for further information.

**Legend**

| | |
|---|---|
| ① | Sensor numbering |
| X/Y/Z | Directions of coordinate system and acceleration |
| $C_{L/R}$ | Center of coordinate system |



# Angular Rate Sensors

| Quantity | Type | Axis | Range | Resolution | Hysteresis | Calibration |
|---|---|---|---|---|---|---|
| 1<br>per side | MEMS<br>LSM6DSL | $\Omega_X$/$\Omega_Y$/<br>$\Omega_Z$ | ±2000 dps | 70 mdsp/LSB<br>16 bit | n.a. | in-factory<br>lifetime |

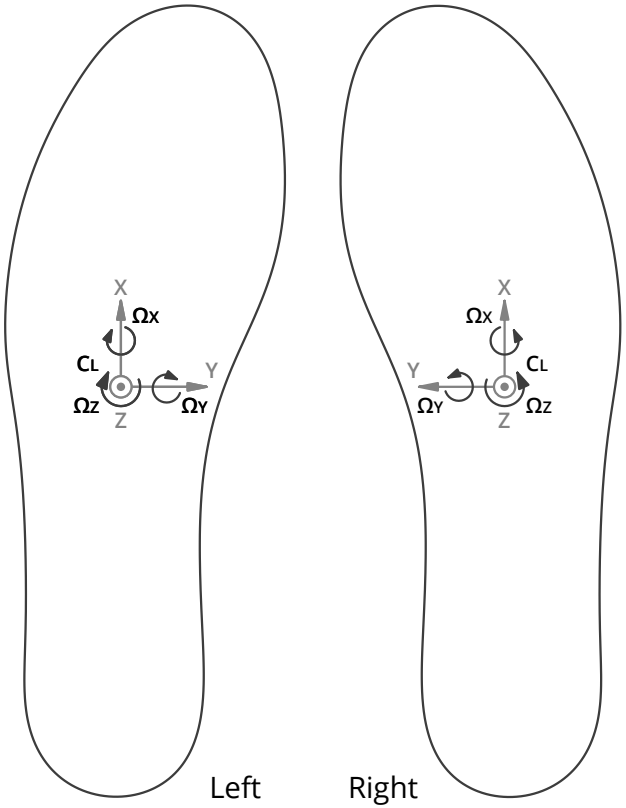
**Notes**

The position of the IMU sensor is at the origin of the coordinate system.
The orientation of the coordinate system is different for left and right sides.
Any coordinates to the sensor centers and outline coordinates of the data output are given in relation to the coordinate system.

Refer to the official LSM6DSL ST Microelectronics datasheet for further information.

**Legend**

| | |
|---|---|
| (1) | Sensor numbering |
| X/Y/Z | Directions of coordinate system and acceleration |
| $\Omega_{X/Y/Z}$ | Angular rates rotation directions |
| $C_{L/R}$ | Center of coordinate system |



# Data Acquisition

| Sample Rates[1] | Memory | Timer [2] | Primary Data Channels [1] | Computed Data Channels [1] |
|---|---|---|---|---|
| 10 Hz | 32 MB [3] | drift ≤ 1 % | TS [2] | COP [X,Y] |
| 25 Hz | FLASH | | PR [1...16] | TF [Z] |
| 50 Hz | non- | | ACC [X,Y,Z] | |
| 100 Hz | extendable | | ANG [X,Y,Z] | |

**Notes**

[1] Sample rates and data channel combinations are software-selectable in the *OpenGo App.*
Each data channel can be activated/deactivated individually. The time stamp channel is always active.

[2] Left and right sensor insoles are time synchronized. Time drift refers to total drift of timing data over time from start of measurement.
Date information (yyyy/mm/dd) from control device, i.e. mobile device/ smartphone, is recorded upon start of measurement.
For the time stamp, the internal clock creates timing information at the resolution of the sample rate (hh:mm:ss.xyz).

[3] From production date 08-2020. Before that date: 16 MB.

**Legend**

TS: Time stamp in s (resolution in ms).
PR: Pressure channels 1 to 16 in N/cm².
ACC: Acceleration channels in X, Y and Z axis direction in g.
ANG: Angular rates about the X, Y and Z axes in dps.
COP: Center of pressure in X and Y axis direction in the range [-0.5...+0.5] related to corresponding sensor insole lenght or width.
TF: Total force (= ground reaction force) in Z axis direction in N.

# Data Acquisition

| Sensor Setup [1] | TR @ 10 Hz | TR @ 25 Hz | TR @ 50 Hz | TR @ 100 Hz | |
|---|---|---|---|---|---|
| Full Setup | 11:20 | 04:32 | 02:16 | 01:08 | hh:mm |
| Standard Setup | 13:58 | 05:35 | 02:47 | 01:24 | hh:mm |
| Monitoring Setup | 32:15 | 12:54 | 06:27 | 03:13 | hh:mm |

| Sensor Setup [1] | TS | PR | ACC | ANG | COP | TF |
|---|---|---|---|---|---|---|
| Full Setup | ● | ● | ● | ● | ● | ● |
| Standard Setup | ● | ● | ● | | ● | ● |
| Monitoring Setup | ● | | ● [2] | | ● | ● |

**Notes**

Recording times refer to continuous data recording in Recording mode. Effective recording times can be higher when using SmartRecording mode for activity triggered data recording. For example, A measurement acquired with standard sensor setup in SmartRecording mode @ 50 Hz can take a up to 5 times of the duration of continuous recording if the wearer of the sensor insoles is only active 20 % of the time.

[1] The depicted sensor setups are setups which are pre-defined in the *OpenGo App.*
Other Sample rates and data channel combinations are software-selectable in the *OpenGo App*.
Each data channel can be activated/deactivated individually. The time stamp channel (TM) is always active.
**Indicated recording times apply for sensor insoles with 32 MB memory produced from 08/2020!**

[2] Only Z axis.

**Legend**

TR: Maximum recording time for continuous on-board data recording.

# Operation Modes

| Standard Modes [1] | Description | Use Case |
|---|---|---|
| Preview | Transmits fixed basic sensor data wirelessly | Live showcasing and activity checks in the *OpenGo App* |
| Live | Transmits sensor data wirelessly to endpoint (cloud/desktop computer) | Direct data transmission for storage on endpoint |
| Record | On-board sensor data recording | Standalone data acquisition without smartphone |
| Transmit | Wireless sensor data transmission from on-board memory to endpoint PC | Transmitting previously recorded sensor data to endpoint for storage on endpoint |

| Intelligence Modes [1] | Description | Use Case |
|---|---|---|
| Smart Recording [2] | Activity triggered recording mode. Recording is only on when users are active. | For longterm gait monitoring |
| Smart Sleep | Automatic shut down into power safe mode when sensor insole is not in use.<br>No hardware switches are used. | No user interaction for turning on/off required |

**Notes**

[1] The operation modes can be selected in the *OpenGo App*.
[2] Smart Recording is an activity triggered recording mode where internal firmware algorithms control the intermediate pausing and resuming in action. The mobile device (phone/tablet) is only required for starting and stopping, not for the recording itself.
For further details on the operation modes refer to the product pages on moticon.com/opengo/app.

# System Functions

| Function | Description |
|---|---|
| Firmware Update | Firmware of the sensor insoles can be updated wirelessly using the *OpenGo App.* |
| File Management | The firmware runs a file management system on the on-board memory of the sensor insoles. Measurements can be selected, deleted and transmitted individually using the *OpenGo App.* |
| System Status | The firmware checks the system status and transmits status information.<br>Status information includes:<br>1. Restarts<br>2. Active time<br>3. Miscelaneous: firmware version, serial number, size, side |
| Battery Status | The firmware detecs the battery charge status of the inserted coin cell batteries.<br>The charge status is transmitted to the *OpenGo App.* |

# Connectivity

| Wireless Standard | Profile | Wireless Range | Bandwidth |
|---|---|---|---|
| BLE 5.0 [1] | proprietary [2] | ≥ 5.0 m [3] | 54 kB/s [4] |

| Data Volume | Download Time [5] | | Recording Equivalent [5] |
|---|---|---|---|
| 28.80 MB [6] | 00:08:54 | hh:mm:ss | 68 min @ 100 Hz Full Setup |
| 4.30 MB | 00:01:20 | hh:mm:ss | 10 min @ 100 Hz Full Setup |
| 0.43 MB | 00:00:08 | hh:mm:ss | 1 min @ 100 Hz Full Setup |

**Notes**

[1] Version refers to integrated wireless chip. BLE connection to smartphones can be established from version 5.0.
[2] No standard BLE profile is used.
[3] Depends on environmental conditions and other active wireless devices.
[4] Maximum data transmission bandwidth. Depends on smartphone performance.
[5] Given times and setups are estimates and shall illustrate expectable download times of previously on-board recorded sensor data to a smartphone using the *OpenGo App*.
[6] Includes 10 % overhead for auxiliary data.

# Connectivity


**Notes**

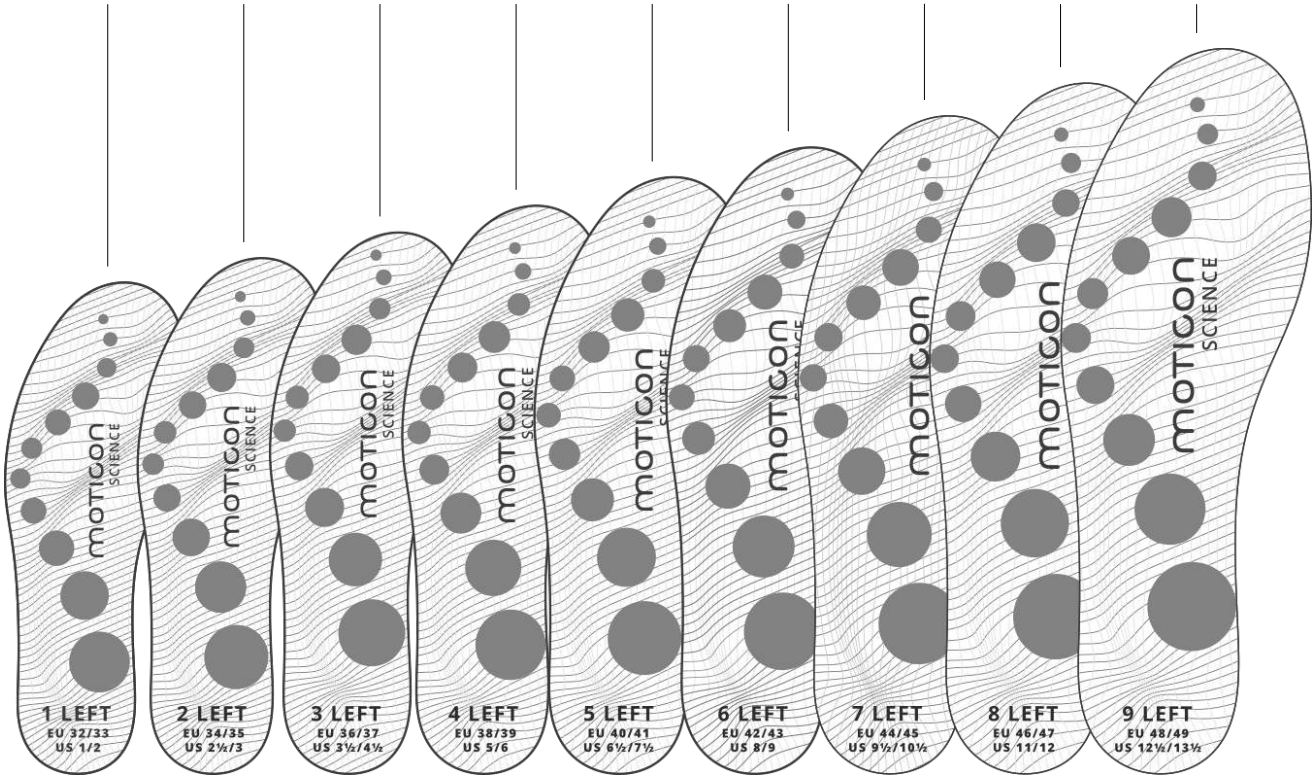
For instructions of use refer to the tutorials on moticon.com/documentation.

**Legend**

--- Wireless data transmission.

# Sizes

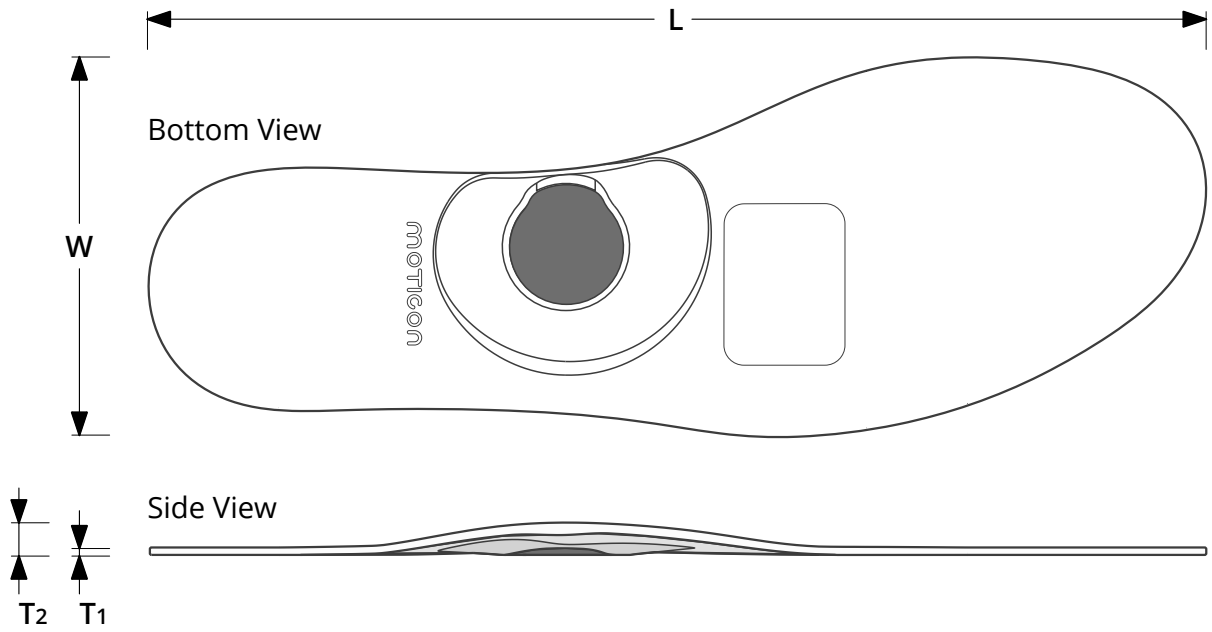
| | Size 1 | Size 2 | Size 3 | Size 4 | Size 5 | Size 6 | Size 7 | Size 8 | Size 9 |
|---|---|---|---|---|---|---|---|---|---|
| **EU** | 32/33 | 34/35 | 36/37 | 38/39 | 40/41 | 42/43 | 44/45 | 46/47 | 48/49 |
| **US** | 1/2 | 2½/3 | 3½/4½ | 5/6 | 6½/7½ | 8/9 | 9½/10½ | 11/12 | 12½/13½ |




**Notes**
Refer to the *OpenGo Sensor Insole* fitting guide for more detailed information moticon.com/opengo/sensor-insole-sizes.

# Sizes

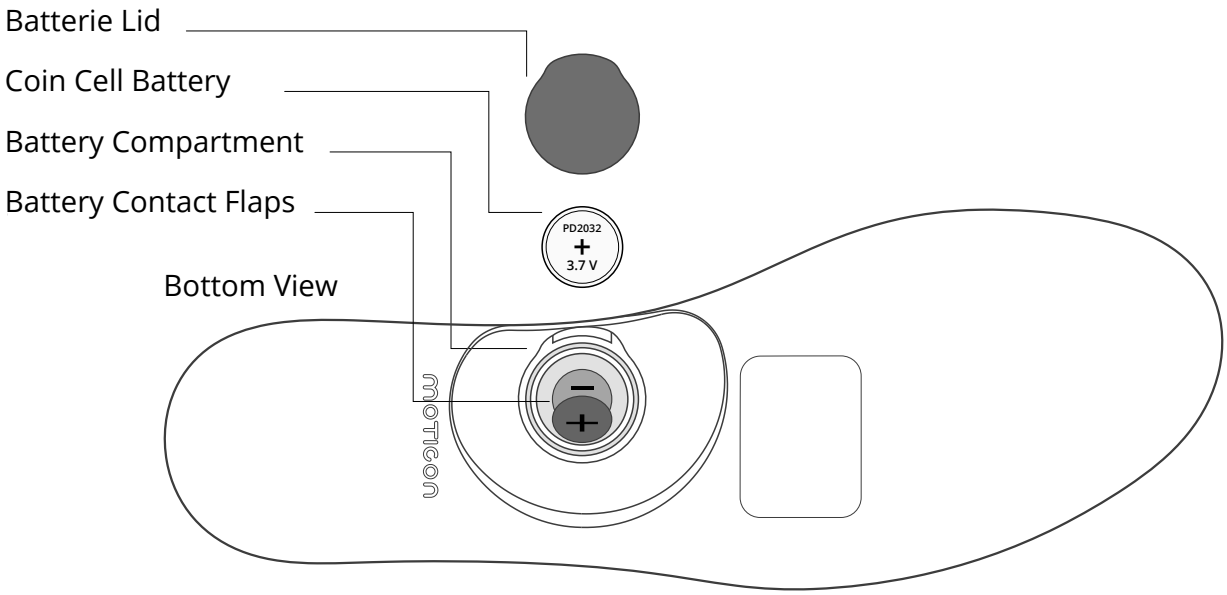
| | Size 1 | Size 2 | Size 3 | Size 4 | Size 5 | Size 6 | Size 7 | Size 8 | Size 9 | |
|---|---|---|---|---|---|---|---|---|---|---|
| **W** | 80.2 | 83.4 | 86.7 | 90.2 | 93.8 | 97.5 | 101.4 | 105.5 | 109.7 | mm |
| **L** | 214.9 | 225.6 | 236.8 | 248.6 | 261.1 | 274.2 | 288.0 | 302.4 | 317.5 | mm |
| **T1** | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | mm |
| **T2** | 10.5 | 10.5 | 10.5 | 10.5 | 10.5 | 10.5 | 10.5 | 10.5 | 10.5 | mm |




**Notes**
Dimensions may vary ± 1.5 mm due to production tolerances.

# Power Supply

| Supply Voltage | Power Consumption | Battery [1] Type | Battery Form Factor | Battery Technology |
|---|---|---|---|---|
| 3.7 V ± 0.4 V | n/a mAh | 1 coin cell rechargeable | 2032 | Lithium Ion |




**Caution:**

[1] Recommended coin cell battery type is PD2032 (Route Jade, South Korea), available from Moticon.
DO NOT USE primary coin cell batteries type CR2032 or mangan based rechargeable coin cell batteries type ML2032.
These batteries have a nominal voltage of 3.0 V and continuous voltage drop in use.
Moticon SCIENCE Sensor Insoles require a minimum operation voltage of 3.2 V. A lower operating voltage causes malfunction.

**Notes**

Refer to the tutorials for coin cell battery handling and charging recommendations on moticon.com/opengo/documentation.

# Imprint



**Further Information**

For more detailed product information, please visit
moticon.com/opengo/sensor-insole
moticon.com/opengo/resources
moticon.com/opengo/documentation

**Release Notes**

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