1. plyon® stretch – Technical Data Sheet

Key Features

- Resistive (Force) and Capacitive (Touch) Readout
- Excellent Signal Quality under Bending and Stretching Conditions
- > 25000x stretchable to at least 20 %
- Highly Customizable Sensor Characteristics and Layout
- Small, Thin, and Durable
- Simple Electrical Interface

Fig. 1: Top and rear view of plyon stretch while being manually stretched

The plyon® platform is a capacitive-resistive, touch, and force sensor based on a versatile layered architecture. It is a new approach to how physically and functionally unique sensor modules can be designed, produced, and integrated. plyon® sensors can be bent down to a radius of 10 mm while maintaining excellent signal integrity (TrueZero™).

Our modules offer an incredible range of problem-solving potential in the fields of close-to-body applications, robotics, body tracking, direct human-machine-interactions, as well as complex surfaces (s. Fig. 2). The stretchable bilayer TPU substrate allows for simple heat press lamination e.g. on textiles.

At a Glance

- Sensing Area: (3 x 3)[c] to (260 x 360) mm^2
- Thickness: 0.7 mm
- Min. Detect. Force: from 0.5 N cm^{-2}
- Max. Detect. Force: up to 30 N cm^{-2}
- Resistance: 1 – 5000 kΩ
- Durability: >25000 cycles (20 % elongation)
- TrueZero™: down to 10 mm bending radius

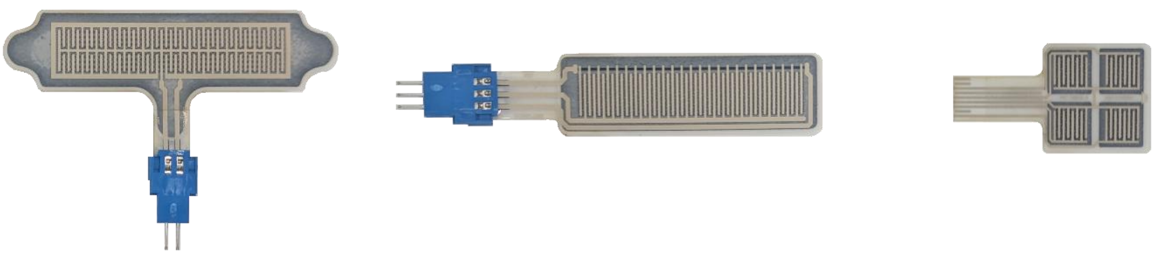
Fig. 2: plyon stretch applied onto a sphere (r=20 mm)

2. Sensor Characteristics

Device Characteristics	Value	Notes
Minimal detectable force[a,b] (Sensitive):	0.5 N cm^{-2}	s. "6. Sensor Tunability"
Minimal detectable force[a,b] (Tough):	2.0 N cm^{-2}	s. "6. Sensor Tunability"
Maximum detectable force[a,b] (Sensitive):	20 N cm^{-2}	s. "6. Sensor Tunability"
Maximum detectable force[a,b] (Tough):	30 N cm^{-2}	s. "6. Sensor Tunability"
TrueZero™ bending radius (Sensitive)[b]:	20 mm	no output signal, while bent over a semi-circular jig with the given radius
TrueZero™ bending radius (Tough)[b]:	15 mm	no output signal, while bent over a semi-circular jig with the given radius
Non-actuated resistance:	>50 MΩ	
Resistance range[b]:	[1, 5000] kΩ	Typical values; depends on sensor variant
Part-to-part (P2P) repeatability[a,b]:	15 %	Variation in response (std. dev. / mean) at 4 N
Durability[b]:	>25000 Cycles	Stretch of unbonded sensor at 20 % and 8.6 mm/s
Hysteresis[a,b]:	<5 %	Calculated at 80 % of the full-scale range, depends on sensor variant
High humidity / high temperature storage[a,b]:	Fully Functional	Change in response after 120 h at 80 °C and 80 %RH

[a] *Tests were conducted on plyon® stretch medium sensor with a cylindrical Nylon (PSHMMC6) contact part of 6 mm diameter, resulting in an actuation area of 0.28 cm².*
[b] *Dependent on several factors, such as geometry and readout electronics.*

Members of the plyon® stretch sensor line
Note: Most designs from the plyon flex series can be used for plyon stretch as well

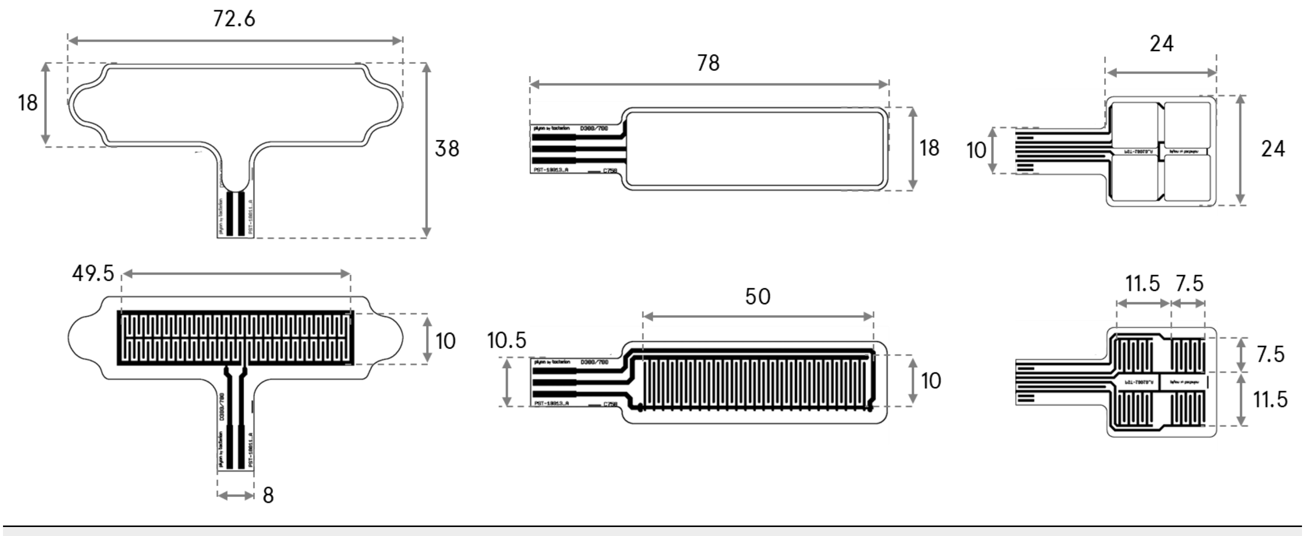


plyon® Medium	plyon® Slider	plyon® 2x2 Array
PST-10011	**PST-10013**	**PST-10010**

Fig. 3: Sensor layouts of plyon® stretch included in the DevKit (l.t.r. Medium, Slider, 2x2 Array). The sensor variants sensitive and tough look the same.

3. General Specifications

Physical properties	Value
Product line:	plyon® stretch (beta)
Sensor generation:	Cheetah
Size of tactile elements[c] (custom size and shapes available):	Min (3 x 3) mm² | (0.12 x 0.12) in² Max (100 x 100) mm² | (3.94 x 3.94) in²
Sensor thickness:	0.70 mm | 0.028 in
Surface materials:	Silicone Elastomer / TPU bilayer
Melt adhesive layer:	Processing at 130°C, e.g. on textile
Electrical connection of flex tail:	Standard: 2.54 mm (0.1 in) pitch (Bare Tail or Flex Connector: Male contacts with 2-/3-pin housing) Arrays: 1 mm (0.04 in) pitch (Bare tail or contacting via ZIF-connector)
Material compatibility:	Typical material compatibility of TPU films and silicones needs to be considered.



plyon® Medium	plyon® Slider	plyon® 2x2 Array
PST-10011	**PST-10013**	**PST-10010**

Fig. 4: Dimensions reported in mm. The dimensions are identical for the sensitive and tough variant. The lower/ backside view outlines the responsive area of the sensors.

[c] *The tactile element size describes only the responsive area of the sensor, and does not comprise the circumscribing frame, which is not responsive. Therefore, the total footprint of the sensor is generally larger than the specified tactile element size.*

4. Sensor Performance

Signal Readout-Force[a,b]

The sensor performance is evaluated by analyzing the signal, which is determined for stepwise increasing/decreasing force levels ranging from 0 N to 10 N with 0.5 N force steps (s. Fig. 5).

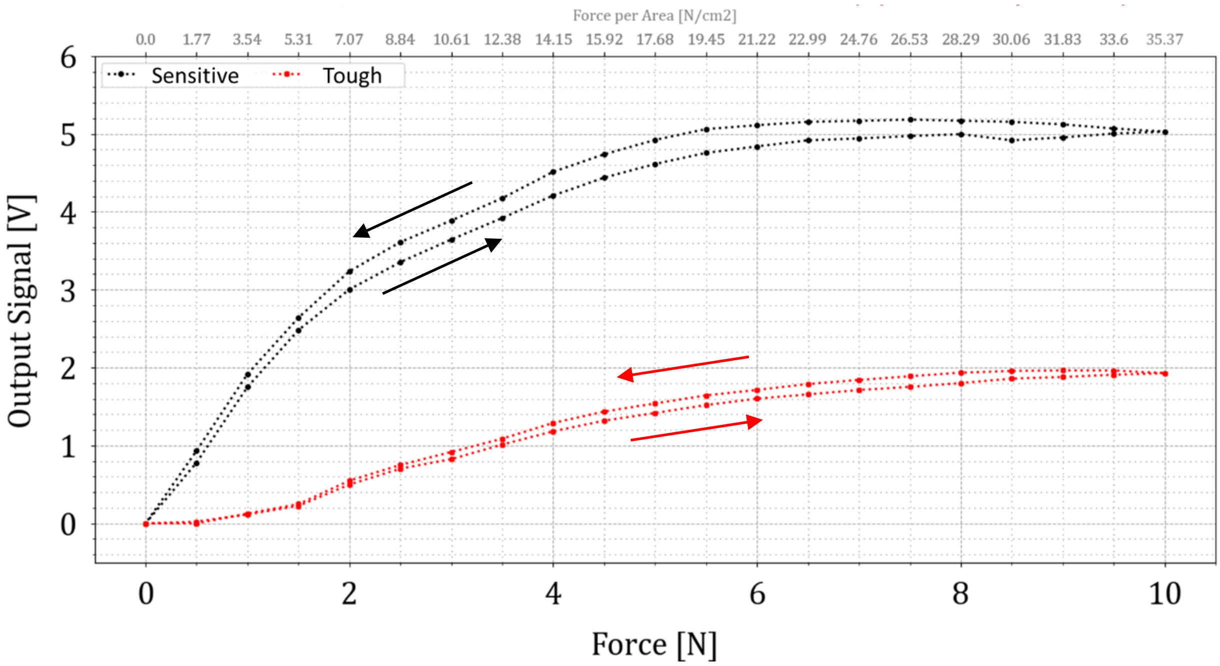


Fig. 5: Sensor performance as signal readout over force for the sensitive and tough version of plyon stretch. The secondary x-axis gives the equivalent pressure during the characterization. Arrows indicate the sweep direction.

The sensor response is measured through the EBS-10010 electronics and the readout values obtained are plotted against the force exhibited at each step. For this purpose, an average of the readout values recorded within each force step is determined.

[a] *Tests were conducted on plyon® stretch medium sensor with a cylindrical Nylon (PSHMMC6) contact part of 6 mm diameter, resulting in an actuation area of 0.28 cm².*

[b] *Dependent on several factors, such as geometry and readout electronics.*

5. Readout Circuits

In the following two possible sensor readout circuits are suggested.
Note that all measurements presented in this datasheet were recorded using the EBS-10010 electronics, which is based on the voltage divider configuration.

a. Voltage divider

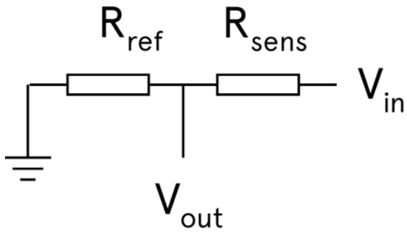


Fig. 6: Schematic of voltage divider circuit.

A voltage divider (s. Fig. 6) configuration is the simplest readout circuit to determine sensor resistance. Given that R_{ref} and V_{in} are known, the sensor resistance R_{sens} can be calculated by measuring the voltage drop V_{out} across the reference resistor R_{ref}.

The output voltage can be expressed as:

$$V_{out} = \frac{V_{in} \cdot R_{ref}}{R_{ref} + R_{sens}}$$

b. Transimpedance Amplifier (I-V converter)

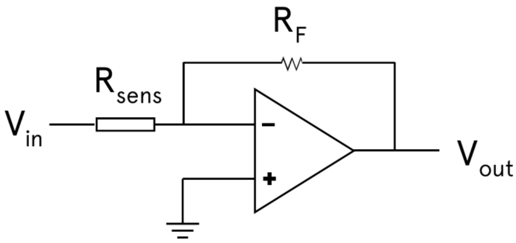


Fig. 7: Schematic of a transimpedance amplifier circuit.

A transimpedance amplifier (TIA, s. Fig. 7) converts the current flowing through the sensor (V_{in}/R_{sens}) to a voltage signal (V_{out}), providing a more ideal transfer function than a voltage divider.

Under the assumption of an ideal op-amp, the output voltage is calculated as:

$$V_{out} = -V_{in} \cdot \frac{R_F}{R_{sens}}$$

6. Sensor Tunability

plyon® stretch offers tunable performance within a specified range, allowing tacterion to adjust key parameters for customers such as sensitivity and force range to optimize for specific applications. The accompanying schematic (s. Fig. 8) illustrates the possibilities for configuring the sensor to meet different operational requirements.

Here, the minimum detectable force is the force per area required to obtain a stable non-zero signal. The maximum detectable force (or saturation force) is defined as the point at which there is little or no change in the signal as more force is applied.

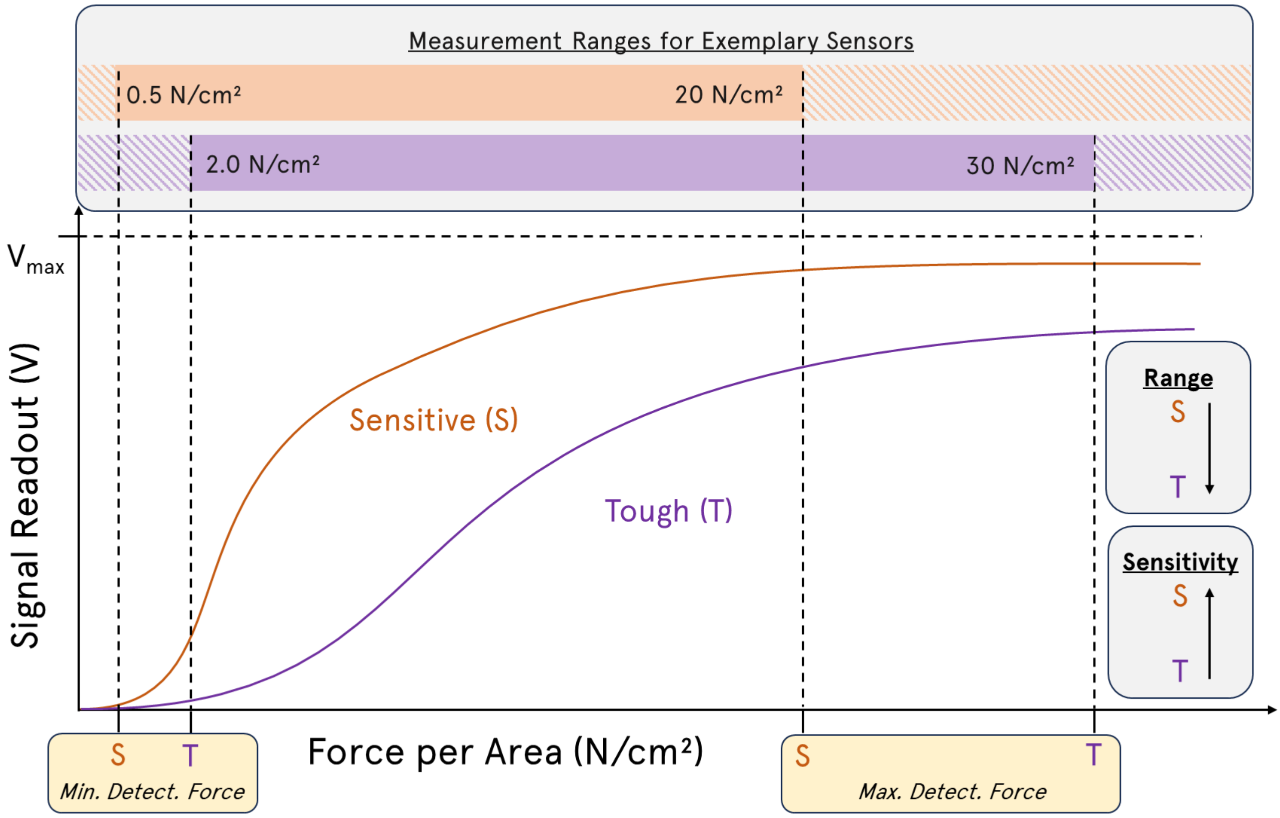


Fig. 8: Schematic illustration of the possibilities to tune the sensor performance. The sensitivity and range can be adjusted by the sensor architecture. Two exemplary sensor response curves are depicted for a sensitive (S) and tough (T) sensor.

The technical information contained herein is believed to be accurate as of the date hereof. Please note that the delivered sensor is a pre-series model. Hence, its characteristics may vary from the ones shown in this datasheet.
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