

# Multicomponent force plate

Type 9287C...

Large – for dynamic applications in biomechanics,  
 $F_z$  –10 ... 20 kN

Multicomponent force plate with wide range for measuring ground reaction forces, moments and the center of pressure in biomechanics.

- Extremely wide measuring range
- Excellent measuring accuracy
- High natural frequency
- Versatile
- Threshold  $F_z$  <250 mN
- Large dimensions

## Description

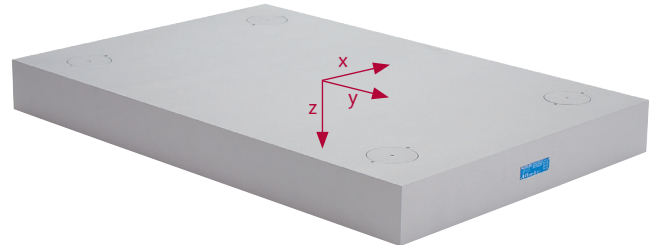
The multicomponent force plate Type 9287C... consists of a 900x600 mm aluminum sandwich top plate of advanced, lightweight construction and four built-in piezoelectric 3-component force sensors. Thus it is extremely rigid overall, and allows measurements over a very wide useful frequency range.

Thanks to the special properties of the piezoelectric sensors, the force plate is highly sensitive and can simultaneously measure very dynamic phenomena involved in a wide range of applications.

## Application

This force plate is designed specifically for use in basic research and sport. Its large size, wide measuring range and high rigidity allow it to be employed for a very wide spectrum of measuring tasks and application sectors. Despite the very generous measuring range of -10 ... 20 kN, it offers excellent accuracy and linearity and even under a large preload allows precise measurement of minute forces. In all these situations the force plate can be mounted in any position without affecting the measurement result in any way.

The Type 9287CA has a built-in charge amplifier compatible with all of the common motion analysis systems.



## Technical data

|                             |                            |              |                           |
|-----------------------------|----------------------------|--------------|---------------------------|
| Dimensions                  |                            | mm           | 900x600x100               |
| Measuring range             | $F_x, F_y$                 | kN           | -10 ... 10                |
|                             | $F_z$                      | kN           | -10 ... 20                |
| Overload                    | $F_x, F_y$                 | kN           | -13/13                    |
|                             | $F_z$                      | kN           | -10/25                    |
| Linearity                   |                            | %FSO         | < $\pm$ 0.2               |
| Hysteresis                  |                            | %FSO         | <0.3                      |
| Crosstalk                   | $F_x \leftrightarrow F_y$  | %            | < $\pm$ 1.5               |
|                             | $F_x, F_y \rightarrow F_z$ | %            | < $\pm$ 1.5               |
|                             | $F_z \rightarrow F_x, F_y$ | %            | < $\pm$ 0.5 <sup>1)</sup> |
| Rigidity                    | x-axis ( $a_y = 0$ )       | N/ $\mu$ m   | $\approx$ 150             |
|                             | y-axis ( $a_x = 0$ )       | N/ $\mu$ m   | $\approx$ 200             |
|                             | z-axis ( $a_x = a_y = 0$ ) | N/ $\mu$ m   | $\approx$ 30              |
| Natural frequency           | $f_n(x, y)$                | Hz           | $\approx$ 750             |
|                             | $f_n(z)$                   | Hz           | $\approx$ 520             |
| Operating temperature range |                            | $^{\circ}$ C | 0 ... 60                  |
| Weight                      |                            | kg           | 25                        |
| Degree of protection        | EN 60529:1992              |              | IP65                      |

## Force plate without charge amplifier, Type 9287C

|                          |                 |      |                    |
|--------------------------|-----------------|------|--------------------|
| Calibrated range         | $F_x, F_y$      | kN   | 0 ... 10           |
|                          | $F_z$           | kN   | 0 ... 20           |
| Calibrated partial range | $F_x, F_y$      | kN   | 0 ... 1            |
|                          | $F_z$           | kN   | 0 ... 2            |
| Threshold                | $F_x, F_y, F_z$ | mN   | <50                |
| Sensitivity              | $F_x, F_y$      | pC/N | -7.5 <sup>2)</sup> |
|                          | $F_z$           | pC/N | -3.8 <sup>2)</sup> |

<sup>1)</sup> inside sensor rectangle

<sup>2)</sup> nominal value

**Force plate with built-in 8 channel charge amplifier, Type 9287CA**

|                          |            |      |                               |
|--------------------------|------------|------|-------------------------------|
| Calibrated range         | $F_x, F_y$ | kN   | 0 ... 5                       |
|                          | $F_z$      | kN   | 0 ... 20                      |
| Calibrated partial range | $F_x, F_y$ | kN   | 0 ... 1.25                    |
|                          | $F_z$      | kN   | 0 ... 5                       |
| Sensitivity range 1      | $F_x, F_y$ | mV/N | $\approx 40^{2)}$             |
|                          | $F_z$      | mV/N | $\approx 18^{2)}$             |
| Sensitivity range 4      | $F_x, F_y$ | mV/N | $\approx 2.0^{2)}$            |
|                          | $F_z$      | mV/N | $\approx 0.9^{2)}$            |
| Ratio ranges 1:2:3:4     |            |      | 1 : 5 : 10 : 20 <sup>3)</sup> |
| Threshold                |            | mN   | <250 <sup>4)</sup>            |
| Drift                    |            | mN/s | < $\pm 10$                    |
| Supply voltage           |            | VDC  | 10 ... 30                     |
| Supply current           |            | mA   | $\approx 45$                  |

|                              |    |               |
|------------------------------|----|---------------|
| Output voltage               | V  | 0 ... $\pm 5$ |
| Output current               | mA | -2 ... 2      |
| Control inputs (optocoupler) | V  | 5 ... 45      |
|                              | mA | 0.4 ... 4.4   |

- <sup>2)</sup> nominal value
- <sup>3)</sup>  $\pm 0.5\%$  accuracy
- <sup>4)</sup> only range 1

Conforms to the CE safety standards (73/23/EG) for electrical equipment and systems:

EN 60601-1:2005, EN 61010-1:2001  
 and the EMC standards (89/336/EG):  
 EN 60601-1:2005 (EN 55022 Class B), EN 61000-6-3:2004 (EN 55022 Class B), EN 61000-6-4:2001 (EN 55011 Class B), EN 60601-1:2005, EN 61000-6-1:2001, EN 61000-6-2:2005

**Dimensions**

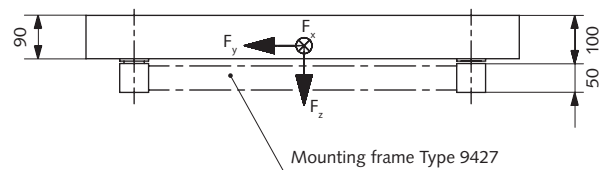
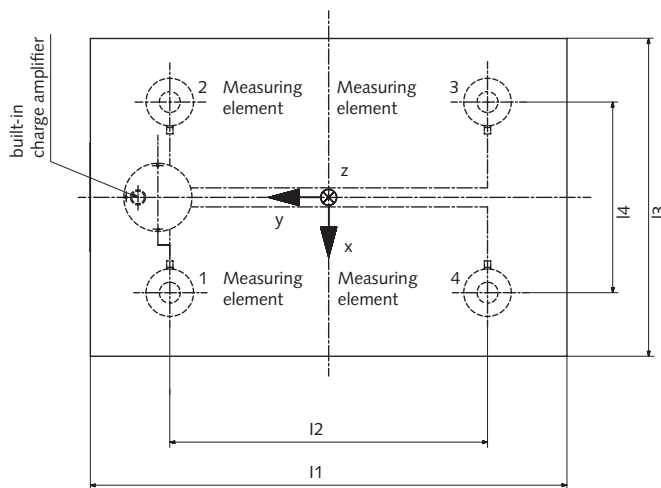


Fig. 1: Dimensions of the large multicomponent force plate Type 9287CA

| Typ       | I1   | I2  | I3  | I4  |
|-----------|------|-----|-----|-----|
| 9287CA    | 900  | 700 | 600 | 420 |
| 9287CAQ01 | 1200 | 700 | 600 | 420 |
| 9287CAQ02 | 900  | 700 | 900 | 700 |

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**BioWare**

BioWare software is the engine behind the force plate system. It collects data from the force plates, converts the trials into useful information and plots the results. The force plates and charge amplifiers are fully remote controlled by BioWare thus making the system extremely flexible and easy-to-use.

**Parameters of Gait**

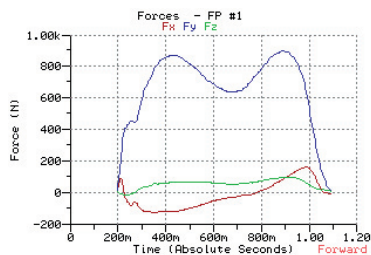


Fig. 2: Ground reaction forces (GRF)

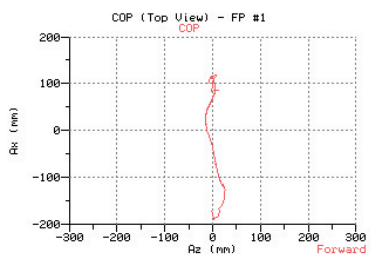


Fig. 3: Center of pressure (COP)

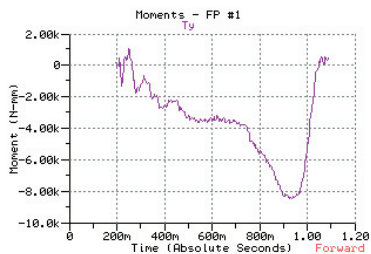


Fig. 4: Frictional torque  $T_z$

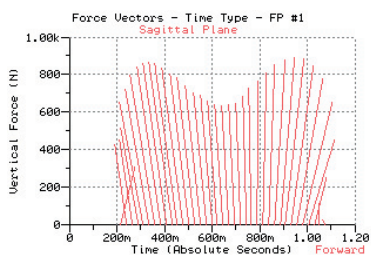


Fig. 5: Force vector

**Other functions**

- Coefficient of friction (COF)
- Frequency analysis, statistics, digital filters
- Full Windows functionality

BioWare provides several performance specific evaluations.

**Parameters of Countermovement Jump CMJ**

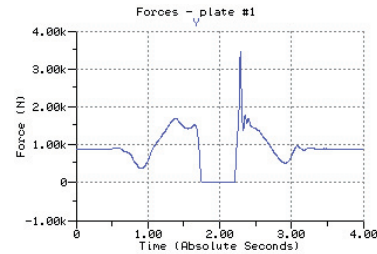


Fig. 6: Jump force

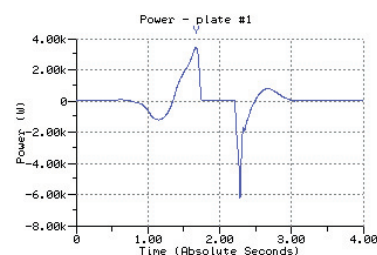


Fig. 7: Power

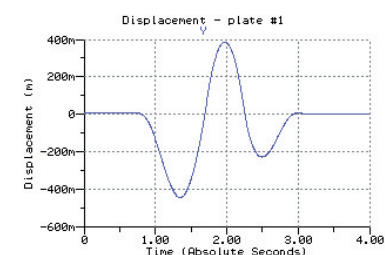


Fig. 8: Jump height (COM)

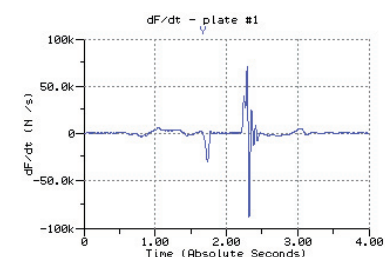


Fig. 9: Force gradient (Explosivity)

**Other parameters**

- Acceleration, velocity and displacement of the center of mass (COM)
- Work, energy, impulse
- Statistics, digital filters

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**Typical measuring chains**





|   |   |  |   |
|---|---|--|---|
|  |  |  |  |
| Force plate with charge amplifier<br>Type 9287CA                                  | Connection cable<br>Type 1759A...   | DAQ system (USB 2.0)<br>Type 5691A1  | Laptop (provided by user)<br>with BioWare   |

Fig. 10: Configuration of a typical measuring chain




|   |   |  |  |
|---|---|--|--|
|  |  |  | Ch 1 = F <sub>x</sub> 1+2    Ch 5 = F <sub>z</sub> 1<br>Ch 2 = F <sub>x</sub> 3+4    Ch 6 = F <sub>z</sub> 2<br>Ch 3 = F <sub>y</sub> 1+4    Ch 7 = F <sub>z</sub> 3<br>Ch 4 = F <sub>y</sub> 2+3    Ch 8 = F <sub>z</sub> 4 |
| Force plate with charge amplifier<br>Type 9287CA                                  | Connection cable<br>Type 1757A...   | External control unit<br>(8xBNC neg.) Type 5233A2                                  | DAQ system provided by user<br>(8 analog channels)   |

Fig. 11: Configuration of a typical measuring chain

**Included accessories**

**For Type 9287C...**

|   | Type/Art. No. |
|---|---------------|
| • 1 Shim set                              | 7.050.011     |
| • 4 Eye bolts M6 with washers             | 6.170.007     |
| • 4 Hexagon socket head cap screws M12x25 | 6.220.040     |
| • 1 Hexagon socket wrench                 | 6.120.106     |
| • 1 Voltage equalizing cable              | 1391          |
| • 4 Installation handles                  | 5.590.175     |
|   | 7.511.437     |

**Mounting frame for Type 9287C...**

|  |            |
|--|------------|
| • Standard mounting frame                          | 9427       |
| • Other mounting frames for multiple installations | on request |
| • Standard mounting frame for 9287C and 9287CAQ01  | 9427       |
| • Standard mounting frame for 9287CAQ02            | Z20342     |

**Optional accessories**

**For Type 9287CA with built-in charge amplifier**

|  | Type/Art. No. |
|--|---------------|
| • 16ch DAQ-System for BioWare (USB 2.0)  | 5691A1        |
| • Connection cable for 5691A, angle plug | 1759A...      |
| • 64ch DAQ-System for BioWare (USB 2.0)  | 5695B1        |
| • Connection cable for 5695B, angle plug | 1700A105A...  |
| • External control unit (BNC out)        | 5233A2        |
| • Connection cable for Type 5233A...     | 1757A...      |
| • DAQ system BioWare (PCI-Bus)           | 2812A...      |

**For Type 9287C with charge output**

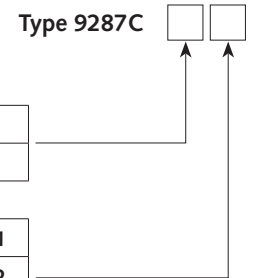
|                                |          |
|--------------------------------|----------|
| • External charge amplifier    | 9865E... |
| • Connection cable, angle plug | 1686A... |
| • DAQ system BioWare (PCI-Bus) | 2812A... |

**Ordering key**

**Large multicomponent force plate**

|                                |   |
|--------------------------------|---|
| with charge output             | – |
| with built-in charge amplifier | A |

|                  |     |
|------------------|-----|
| 1200 x 600 x 100 | Q01 |
| 900 x 900 x 100  | Q02 |
| 900 x 600 x 100  | –   |



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