Instruction Manual

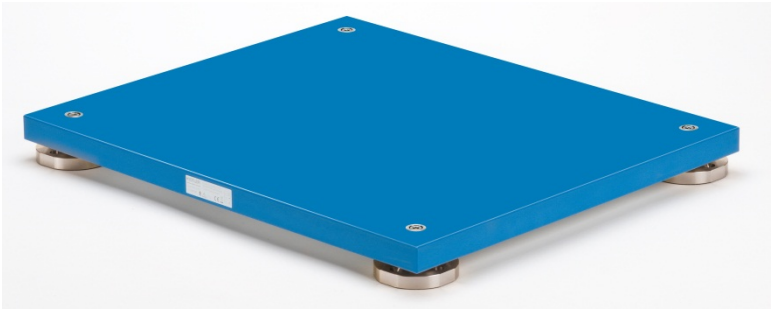
Portable Multicomponent Force Plate for Gait- and Balance Analysis in Biomechanics Type 9260AA...

CE

9260AA_002-479e-11.12

KISTLER

measure. analyze. innovate.



Instruction Manual

Portable Multicomponent Force Plate for Gait- and Balance Analysis in Biomechanics Type 9260AA...

CE

9260A_002-479e-11.12

Foreword

We thank you for choosing a Kistler quality product distinguished by technical innovation, precision and long life.

Information in this document is subject to change without notice. Kistler reserves the right to change or improve its products and make changes in the content without obligation to notify any person or organization of such changes or improvements.

Kistler Group
Eulachstrasse 22
8408 Winterthur
Switzerland
Tel. +41 52 224 11 11
Fax +41 52 224 14 14
info@kistler.com
www.kistler.com

Content

Total Pages 41

1. Introduction

Please take the time to thoroughly read this instruction manual. It will help you with the installation, maintenance, and use of this product.

To the extent permitted by law Kistler does not accept any liability if this instruction manual is not followed or products other than those listed under *Accessories* are used.

Kistler offers a wide range of products for use in measuring technology:

- Piezoelectric sensors for measuring force, torque, strain, pressure, acceleration, shock, vibration and acoustic-emission
- Strain gage sensor systems for measuring force and moment
- Piezoresistive pressure sensors and transmitters
- Signal conditioners, indicators and calibrators
- Electronic control and monitoring systems as well as software for specific measurement applications
- Data transmission modules (telemetry)

Kistler also develops and produces measuring solutions for the application fields engines, vehicles, manufacturing, plastics and biomechanics sectors.

Our product and application brochures will provide you with an overview of our product range. Detailed data sheets are available for almost all products.

If you need additional help beyond what can be found either on-line or in this manual, please contact Kistler's extensive support organization.

2. Important Information

Please keep to the following rules without fail. This will ensure your personal safety when working, and assure long, trouble-free performance by the instrument.

2.1 For your Safety

- This instrument has been tested thoroughly and it left the works in a perfectly safe condition. To maintain this condition and assure safe operation, the user must observe the directives and warnings contained in these instructions
- The force plate must be installed, operated and maintained only by persons who are familiar with it and adequately qualified for their particular tasks
- When it must be assumed that safe operation is no longer possible, the instrument must be taken out of operation and secured against unintentional use

It must be assumed that safe operation is no longer possible if:

- the instrument is visibly damaged
- it no longer functions
- it has been in lengthy storage under adverse conditions
- it has received rough treatment during transport

Please mount the force plate on its foundation following the instructions in chapter 4. Assembly, installation and putting into operation.

According to safety requirements the following has to be observed:

The force plate has to be connected to earth using the Potential Equalization Conductor provided in the scope of delivery to meet the CE-standards regarding Earth Leakage Current.

The data acquisition computer and persons who are in direct contact with it have to remain in a distance of 1,5 m from the patient at all times for the same reason.

2.2 CE-Conformity

The Force Plate Type 9260AA… is conforming to CE directives according to the Declaration of Conformity enclosed with these operating instructions.

2.3 How to Treat the Instrument

- The force plate may be used only under the specified environmental and operating conditions
- Protect the signal output against dirt and do not touch it with your fingers. When the connection is not being used, cover it with the cap provided
- When the force plate is not in use, protect it by keeping it in the packing case supplied
- When performing long-time measurements, make sure that the temperature of the force plate remains as constant as possible

2.4 Hints for Using the Operating Instructions

We recommend reading the entire Operating Instructions as a matter of principle. If you're in a hurry, however, and you've already gathered experience with Kistler force plates, you can confine your reading to the information that you really need.

We have endeavored to arrange these instructions so that you can find the information you need without difficulty.

Please keep these Operating Instructions in a safe place where they can be consulted any time.

If the instructions get lost, just turn to your Kistler distributor and they will be replaced without delay.

All information and directives in these instructions may be modified at any time without prior notification.

2.5 What Happens After Modifications?

Modifications to instruments result in alterations of the operating instructions as a rule. In such cases, enquire at your Kistler distributor about the possibilities of updating your documentation.

2.6 Disposal Instructions for Electrical and Electronic Equipment

Do not discard old electronic instruments in municipal trash. For disposal at end of life, please return this product to an authorized local electronic waste disposal service or contact the nearest Kistler Instrument sales office for return instructions.

3. General Description of the Instrument

3.1 What does a Multicomponent Force Plate Do?

The multicomponent force plate provides dynamic and quasistatic measurement of the 3 orthogonal components of a force (F_x, F_y, F_z) acting from any direction on the top plate.

With the aid of optional evaluation devices (e.g. software system BioWare®) the following quantities can also be measured:

- The moments M_x, M_y and M_z
- The coordinates a_x and a_y of the point of application of force on the force plate surface COP = Center of Pressure
- The torque T_z (free moment) about an axis normal to the force plate surface
- Center of mass displacement and acceleration, physical power and work, coefficient of friction

The multicomponent force plate Type 9260AA… has the following outstanding features:

- Excellent center of pressure (COP) accuracy
- Available in two different sizes
- Easy mounting
- Flexible, mobile application
- Versatile installation
- Threshold F_z <250 mN

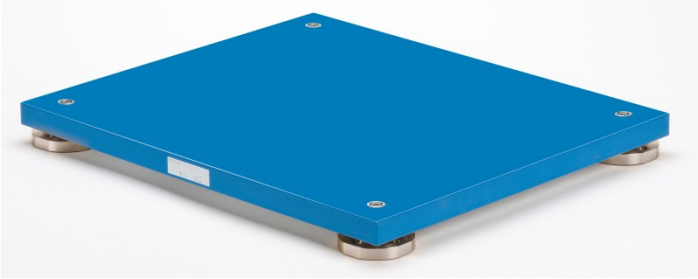


Fig. 1: Portable multicomponent force plate Type 9260AA…

3.2 Available in Two Different Sizes

The force plate Type 9260AA... is available in two different sizes:

- Type 9260AA6 with 600x500 mm
- Type 9260AA3 with 300x500 mm

3.3 Application Examples

The force plate is designed specifically for use in gait and balance analysis. The Type 9260AA... is fitted with an integrated charge amplifier compatible with all of the current motion analysis systems. The force plate is ideal for measuring slow and medium-fast activities, where center of pressure accuracy is particularly important, or portability necessary.

- Gait analysis, for example recording of the forces exerted by our feet while standing, walking or running
- Balance analysis, orthopedic investigations and posturography
- Determining rehabilitation progress, for example with prostheses, after fractures, etc.
- Coefficients of friction can be determined statically and dynamically with the BioWare software package

For dynamic applications (e.g. in sports) it is advisable to use a force plate with very high natural frequency, such as Type 9281E… or Type 9287C… .

3.4 Functional Principle

The force to be measured is introduced via a top plate and distributed between four 3-component force sensors arranged between mounting base and top plate.

Each of the sensors has three pairs of quartz plates, one sensitive to pressure in the z-direction and the other two to shear in the x- and y-directions respectively. The measurement is virtually without displacement.

In these four force sensors the force introduced is resolved into three components.

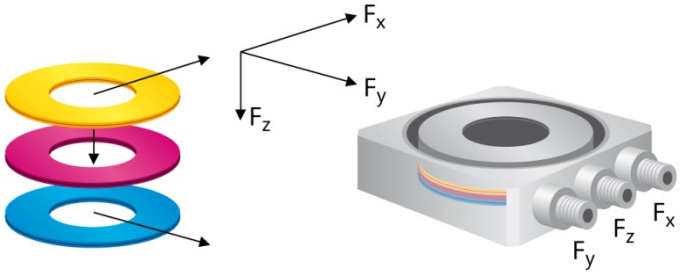


Fig. 2: 3-component force sensor

The electrical charges yielded by the force plate are strictly proportional to the measured quantities. They are converted by charge amplifiers into analog voltages and can then be processed in any way.

Negative charges give positive voltages at the output of the charge amplifier, and vice versa.

Out of the 12 output signals of the 4 sensors, 2 each of the shear forces which have the same line of action can be paralleled (e.g. F_{x1} and F_{x2} to obtain F_{x1+2}, etc.). Therefore, only 8 signals are needed for further processing.

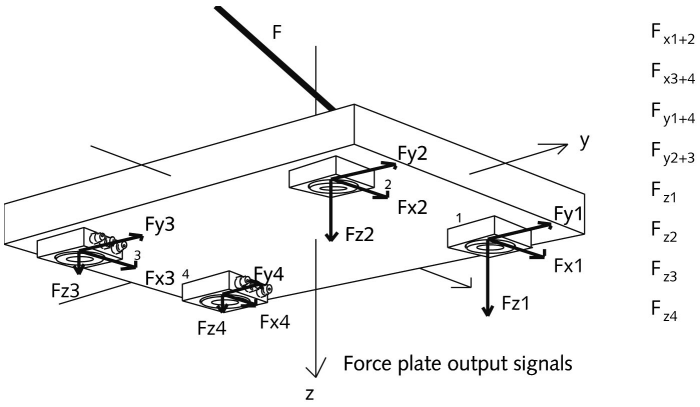


Fig. 3: Force plate output signals

3.5 Design of the Force Plate

The force plate has an aluminum sandwich cover plate under which the four 3-component force sensors are mounted under a high preload.
This preload is a prerequisite for transmitting shear forces by friction.

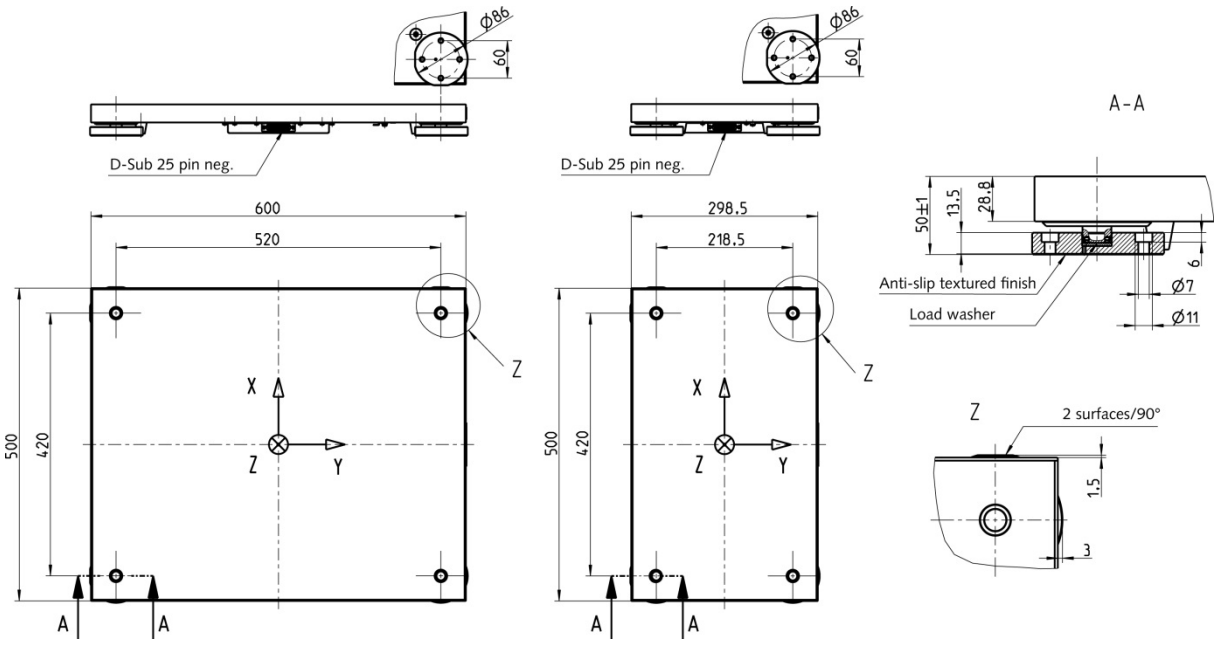


Fig. 4: Dimensions and assembly of the multicomponent force plate Type 9260AA…

The four preloading bolts constitute at the same time the legs on which the force plate stands. The bases are attached movable at the convex lower ends of the legs.

This design allows extremely accurate measurements despite the thin top plate.

To compensate for unevenness, washers may be fitted between the preloading bolts and the bases. The non-slip covering underneath the bases prevents the force plate from slipping away.

If the force plate is recessed into the floor or a walkway, the projecting bases prevent contact between the top plate and the frame, which might otherwise cause measuring errors.

4. Assembly, Installation and Putting Into Operation

4.1 Important Remarks

The multicomponent force plate Type 9260AA... is a precision instrument, however its inherent accuracy can only be exploited and retained if it is treated carefully. The following points should be observed:

- Never drop the force plate or expose it to heavy impacts! The maximum force of a shock of this kind could exceed the measuring range of the instrument and cause damage
- For safety reasons the force plate must be connected to protective ground with a separate ground wire, using the 6,3x0,8 connector provided for this purpose on the underside of the plate
- A modular walkway Type 9418A… opens up very cost-effective, versatile mounting options for one or more force plates. It can be mounted without construction work
- Mounting frames Type 9428A... are available for permanent or flush mounting in the floor. It is also possible to install multiple frames that allow mounting of several force plates and dummies in different arrangements
- The force plate may only be mounted by persons suitably qualified for this work

Please refer to the instruction Manual 002-034 "Force Plate Installation and Maintenance" for detailed procedures and information.

For nonobservance of the mounting instructions Kistler will decline all responsibility.

4.2 Choice of Location

The portable multicomponent force plate Type 9260AA… needs no foundation and can therefore be set up anywhere. Nevertheless the location must satisfy certain requirements listed below, if exact and reproducible measurements are to be obtained.

Suitable surfaces for placing the force plate are concrete, cement and linoleum floors with hard subfloor.

- The floor must be clean and slip-proof to ensure a firm placement of the force plate
- The floor must be level. Only minimal unevenness up to 2,0 mm can be compensated for with the washer set between bases and preloading bolts
- The floor must be hard. If it is too soft (like carpeting, wood, earth) the behavior of the force plate will deteriorate for dynamic measurements, or it will sink in under load
- The floor must transmit little vibration. Even small vibrations may disturb the measurements considerably

4.3 Placing the Force Plate

- Thoroughly clean the floor on which the force plate is to stand, and allow it to dry
- Carefully place the force plate on the floor and bring it into position
- Check whether the force plate rocks by pressing strongly and alternately on diagonally opposite corners of it
- If rocking is detected, it must be eliminated with the washers supplied, even if the rocking is only slight. The bases of the force plate can be removed by hand for this
- The feet of the plate can be removed by hand to enable insertion of the washers
- The feet of the force plate are provided with a very effective textured finish to prevent people slipping accidentally
- If required, the feet can also be screwed to the floor with M6 screws. A gage must be used to ensure the feet are positioned very accurately

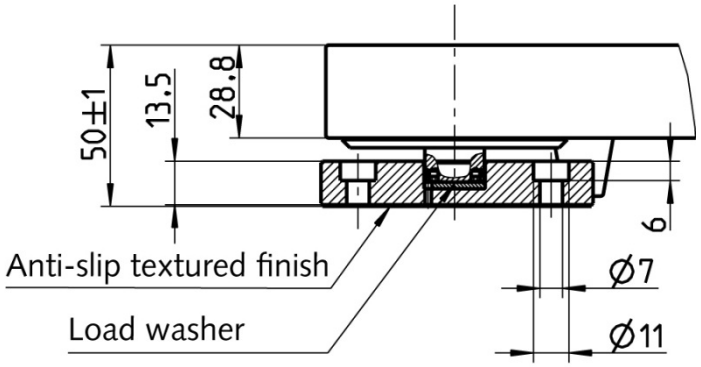


Fig. 5: Washer for compensating floor unevenness

Always shim the force plate at one corner only, never using more than 2 mm of washers altogether. Often a position free from rocking can be found very easily by shifting the force plate to and fro a little and repeatedly checking it for rocking.

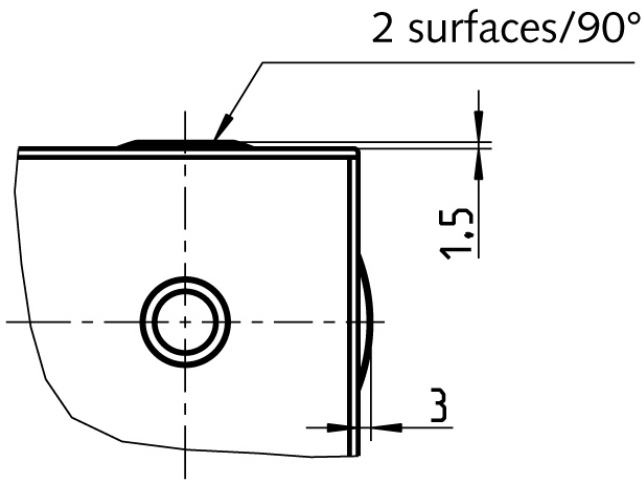


Fig. 6: The feet of the force plate can be turned so they project either 1,5 mm or 3 mm as required

NOTE

To rule out the possibility of force shunts causing measuring errors, the cover plate of the force plate must be positioned with a gap of at least 3 mm from the surroundings or the next force plate. The feet of the plate therefore project beyond the cover plate.

4.3.1 Floor Recessing

If the force plate is to be used for gait analysis it must be recessed into the floor and provided with the same floor covering as its surroundings. This will prevent the test person concentrating too much on the plate so that his gait is altered.

When the force plate is recessed, into a walkway for example, make sure that neither the top plate nor the floor covering fixed on it touch the surroundings. This prevents force shunts, which can lead to measuring errors. To avoid this the feet are turned so their round surface projects 3 mm beyond the cover plate.

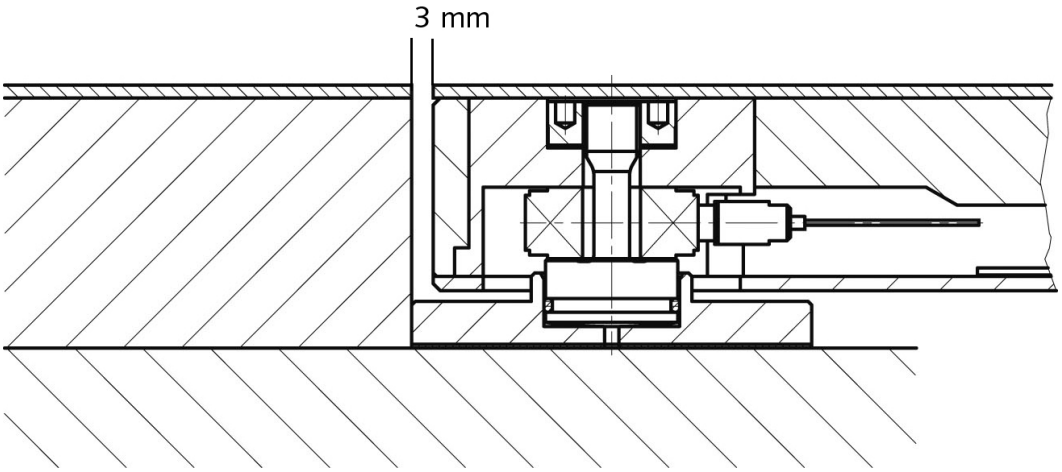


Fig. 7: Recessed force plate. The 3 mm projecting bases prevent the top plate touching the surroundings

4.3.2 Arranging Several Force Plates Side by Side

In order to arrange several force plates Type 9260AA... right next to each other the feet have to be turned so they still project only 1,5 mm beyond each plate (smooth surface on the foot). This achieves a total gap of 3 mm.

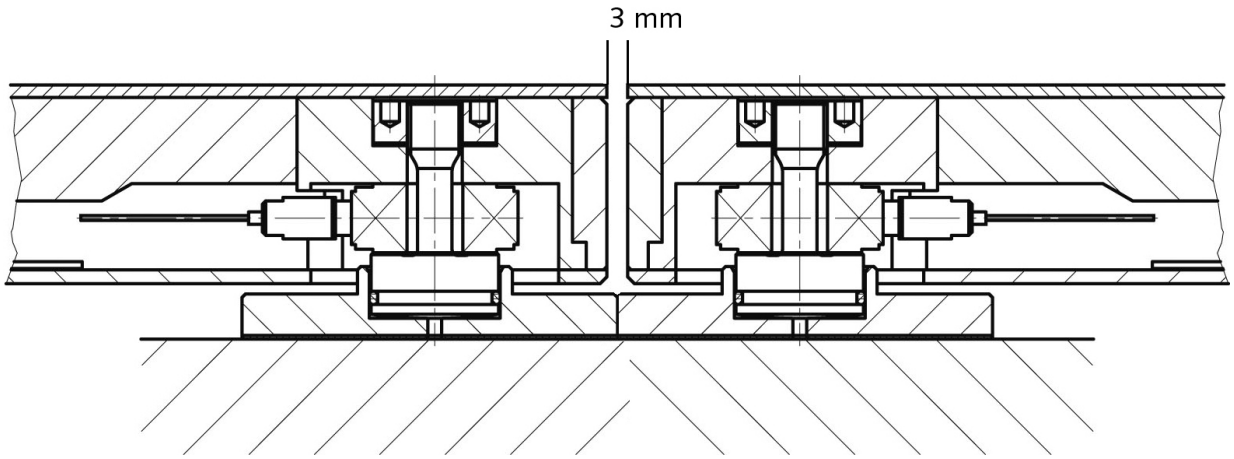


Fig. 8: 2 force plates Type 9260AA... in parallel

4.4 Versatile Mounting

- The walkway solution opens up very cost-effective yet versatile options for mounting one or more force plates
- Different mounting frames are available for permanent or flush installation in the floor
- It is also possible to install multiple frames that allow mounting of several force plates and dummies in different arrangements

4.4.1 Walkway Type 9428A for Mounting on Floor

Various components are available for mounting a walkway. These can be assembled with force plates in different arrangements of any length and width as required. To ensure a consistent surface, the individual components of the walkway are provided with the same anti-slip textured finish as the force plates.
The walkway is 50 mm high to match the force plates.
The gap between all of the walkway components and force plates is always 3 mm.

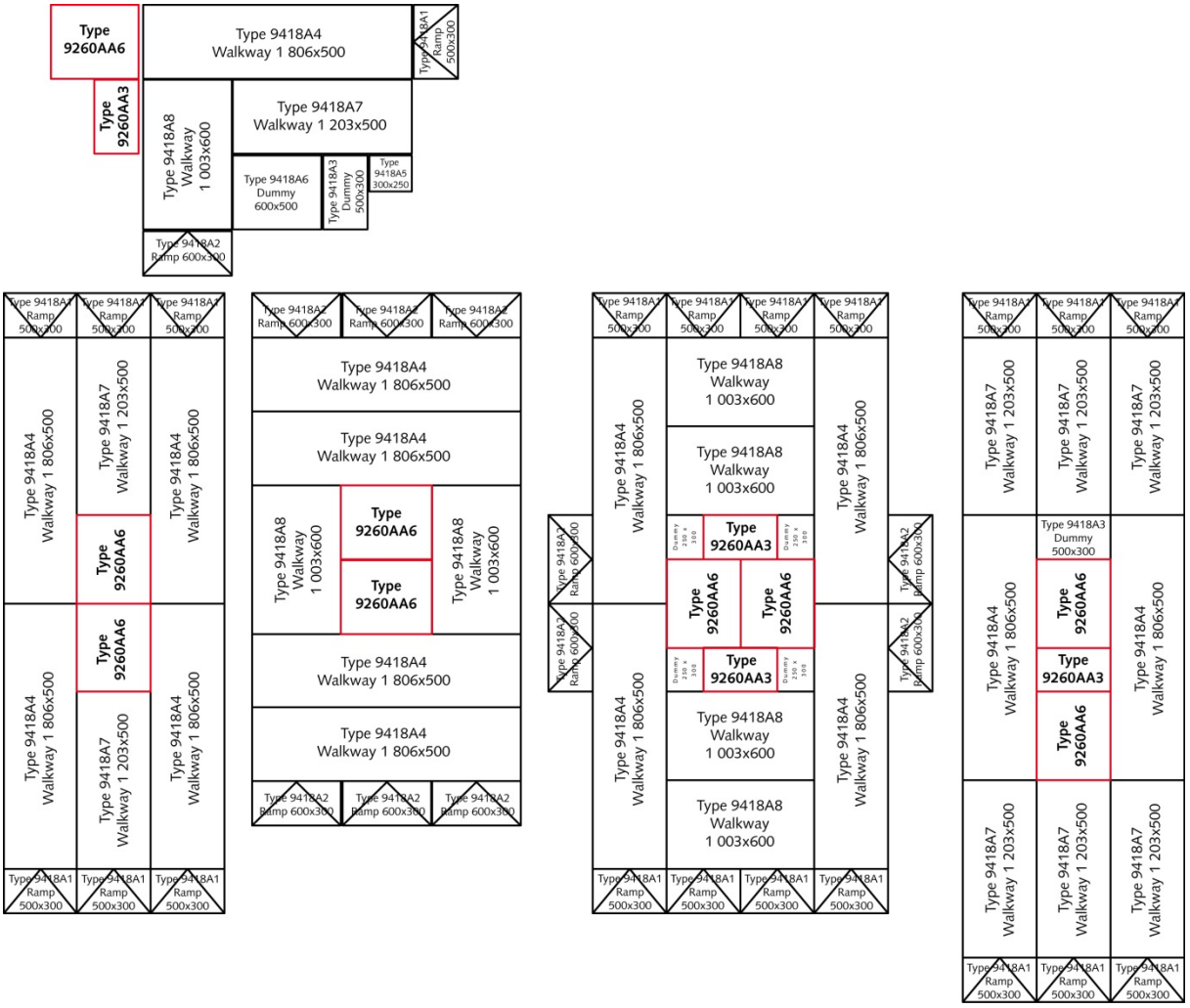


Fig. 9: Examples of mounting with walkway Type 9418A...

4.4.2 Permanent, Flush Mounting in Floor

Permanent or flush mounting in the floor has the advantage of allowing gait analysis to be performed directly at the level of the laboratory floor. This mounting option is particularly suitable if the laboratory floor is so very uneven the method of mounting described in Section 4.4.1 becomes problematic.
However, it requires a 95 mm deep recess to be allowed for in the floor, in which the mounting frame is permanently bonded to the foundation with a suitable epoxy grout.
To retain mounting flexibility, frames allowing different mounting arrangements can also be installed. Several force plates can then be mounted in a different position or used longitudinally and transversely at the same time as required.
Type 9418A3 and 9418A6 dummies can be mounted on the mounting frame in place of force plates of the same size.

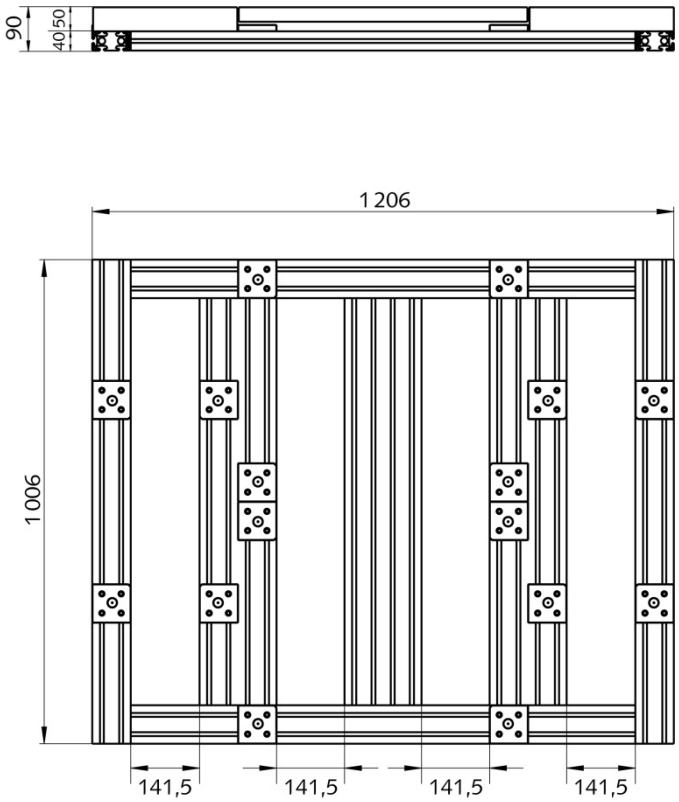


Fig. 10: Mounting frame Type 9428A1

4.5 Basic Circuitry and Cabling of the Measuring System

The electric charges (in pC) yielded by the force plate are converted by charge amplifiers into proportional voltages, which in turn can be displayed, recorded or further processed using appropriate equipment.

The following rules should be observed when cabling the measuring station:

- Between force plate and charge amplifier the special cables supplied by Kistler must be used
- Ordinary cables may be used to link the charge amplifiers with the display or evaluation instruments
- Make sure that all work with electrical connections is done carefully and with cleanliness. Remove the protective caps from the connections only immediately before connecting a cable

According to safety requirements the following has to be observed:

The force plate has to be connected to earth using the Potential Equalization Conductor provided in the scope of delivery to meet the CE-standards regarding Earth Leakage Current.

The data acquisition computer and persons who are in direct contact with it have to remain in a distance of 1,5 m from the patient at all times for the same reason.

4.6 Connections with Built-In Amplifier (Type 9260AA…)

The following figure shows the elements required for a complete measuring system.

Fig. 11: Measuring system with BioWare® and two force plates Type 9260AA…

Instead of the BioWare software system also other processing and indicating instruments can be connect to the force plate. A control unit Type 5233A2 is available for power supply and remote controlling.

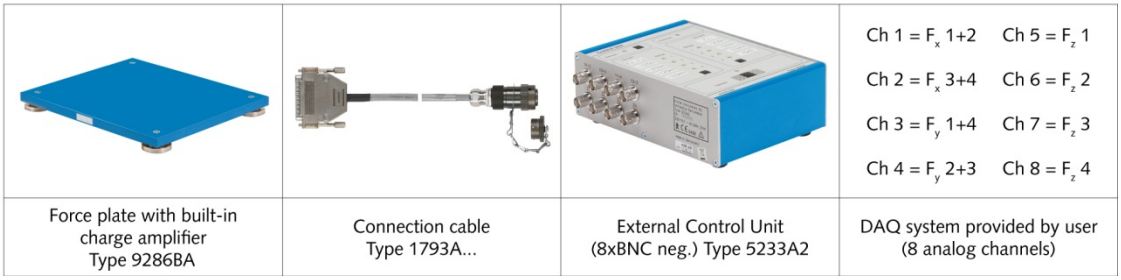


Fig. 12: Measuring system with one force plate and control unit Type 5233A2

4.6.1 Connector of Force Plate Type 9260AA... with Built-In Amplifier

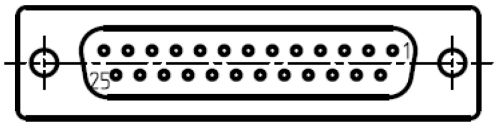


Fig. 13: Socket type: D-Sub 25 neg.

1	A (Range x,y select)
2	Operate
3	F_{y2+3}
4	F_{x1+2}
5	Signal GND
6	N.C.
7	A' (Range z select)
8	F_{z1}
9	F_{z3}
10	Signal GND
11	N.C.
12	N.C.
13	Exct. GND
14	B (Range x,y select)
15	Control GND
16	F_{x3+4}
17	F_{y1+4}
18	N.C.
19	N.C.
20	B' (Range z select)
21	F_{z4}
22	F_{z2}
23	(Test/noTest)
24	(overload)
25	Exct. +10 ... 30 VDC

4.6.2 Cable Type 1769A...

A cable Type 1791A... (D-Sub 25 pos.) connects the 25 pole D-Sub connector of the force plate to a D-Sub 37 pole negative connector and is compatible with all Bio-Ware data acquisition systems.

Signal GND	19		37	F_{x12}
Signal GND	18		36	F_{x34}
Signal GND	17		35	F_{y14}
Signal GND	16		34	F_{y23}
Signal GND	15		33	F_{z1}
Signal GND	14		32	F_{z2}
Signal GND	13		31	F_{z3}
Signal GND	12		30	F_{z4}
Signal GND	11		29	Control GND
NC	10		28	Control GND
A' Range Select Group II	9		27	B' Range Select Group II
NC	8		26	NC
Exct. GND	7		25	Reserved
NC	6		24	NC
NC	5		23	Operate/NotReset
A Range Select Group I	4		22	B' Range Select Group I
Reserved	3		21	NC
NC	2		20	NC
Exct. +10 ... 30 VDC	1			

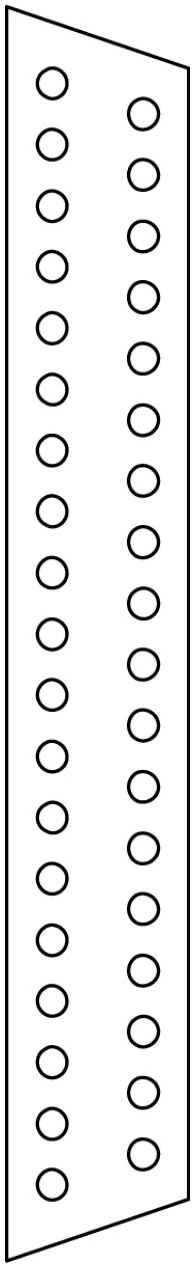


Fig. 14: D-Sub 37 neg.

4.6.3 Digital Control

All Digital Inputs are isolated with optocouplers:

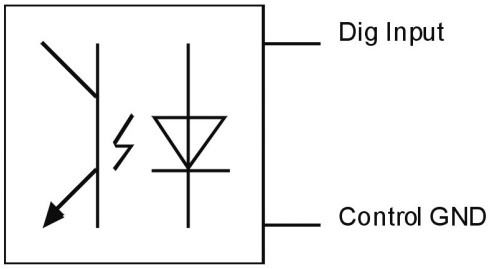


Fig. 15: Digital Control input circuit

Logical Signal	Dig. Input
0	<4,4 V
1	5 ... 45 V

Table 1: Digital Control input signals

Range Select Group I F_x, F_y (Shear)		Range Select Group II F_z (Vertical)		
B (Pin 22)	A (Pin 4)	B' (Pin 27)	A' (Pin 9)	
0	0	0	0	Range 4 (largest)
0	1	0	1	Range 3
1	0	1	0	Range 2
1	1	1	1	Range 1 (smallest)

Table 2: Range Selection

Operate (Pin 6)	Dig. Input
1	Operate
0	Reset

Table 3: Operate/Reset

5. Operation

5.1 Range Selection

Below are range recommendations for different applications. It is important that for every application the smallest possible range is chosen. This will take full advantage of the maximum output voltage thus keeping noise and other errors the smallest possible.
If, however, too small a range is chosen, one or more analog channels may be loaded beyond the limit of the possible measuring range (maximum output voltage). This results in incorrect values, as the force peak is truncated because it can no longer be measured.

	Range F_x, F_y	**Range F_z**
Balance, Microvibrations	1	1 ... 2
Gait	1 ... 2	1 ... 2
Running	2 ... 3	2 ... 4
Impact	1 ... 4	3 ... 4

Table 4: Guidelines for range selection.

5.2 Operate/Reset

The charge amplifier has to bi switched from RESET to OPERATE before applying any force and starting the measurement. All forces are tared (set to zero) at this moment.

Reason: The charge amplifier is an integrator which needs resetting before every measurement. It converts the electric charge yielded by the sensor into an output voltage which is proportional to the applied force.

Exception: Microvibrations can be measured, using the smallest range of the charge amplifier and taring the weight of the subject by switching form RESET to OPERATE after the subject stands still on the force plate.

5.2.1 Balance (Balance Analysis, Posturography)

It is imperative the charge amplifier is switched to OPERATE before the subject steps onto the force plate. Otherwise Center of Pressure COP can not be calculated correctly.

5.3 Usable Frequency Range

The force plate Type 9260AA… has 200 Hz natural frequency. The frequency response curve indicates how strongly each frequency is amplified or attenuated.
See chapter 8.3 Frequency Response.

Impacts like those which occur in sports have a large content of high frequencies. The more rapid and abrupt an impact is, the greater the content of high frequencies.

The force plate as a mechanical system oscillates at its natural frequency when excited. Certain frequency components of an impact are amplified whereas others are attenuated.

The lowest natural frequency of a force plate is determinant for its performance.
For example 200 Hz is the relevant natural frequency of a force plate which has:

- 1 000 Hz natural frequency in vertical direction
- 200 Hz natural frequency in shear direction

5.4 Temperature Influences

The fact that the temperature coefficient of the sensitivity is negligibly small means the sensitivity of the sensors does not change with temperature.

However, temperature gradients lead to generation of an error signal in the form of drift. This deviation with temperature depends on the heat input and is particularly evident while the temperature of the preloading elements is changing. Due to the high rigidity of these elements their thermal expansion can produce very large forces on the sensors.

Any similar variation of all four vertical (F_{z1} ... F_{z4}) signals is generally attributable to thermal drift.

To prevent thermal drift the force plate must be kept at a constant temperature throughout measurement.

The RESET function of the amplifier automatically compensates for the zero offset.

Protect the force plate from direct sunlight to prevent substantial temperature changes during measurement.

5.5 Polarity of the Measuring Signal

5.5.1 x- and y-Directions

When a force acts on the surface and in the direction of the engraved arrow, a negative charge results on the corresponding sensor. It is converted into a positive output voltage by the charge amplifier.

5.5.2 z-Direction

A compressive force (vertical to the supporting surface) likewise generates a negative charge signal and hence a positive output voltage on the charge amplifier.

6. Maintenance

Please refer to the instruction manual 002-034 "Force Plate Installation and Maintenance" for detailed procedures and information.

The multicomponent force plate Type 9260AA... is a dependable instrument requiring virtually no maintenance.
To ensure long and reliable operation of the force plate, please read the next two sections.

6.1 Recalibration of the Instrument

The four 3-component force sensors in the force plate have quartz sensing elements. The output signal results from the piezoelectric effect in quartz. The electric charge yielded is exactly proportional to the acting force. The sensitivity is a constant depending on the material and always remains the same over the service life of the sensor. Recalibration is therefore not necessary as a matter of principle.

It is nevertheless advisable to perform regular operating tests to check whether all parts of the system (connectors, amplifiers, etc.) are working perfectly. The integrated charge amplifier is the component in which a shortcoming (zero offset and drift) is most likely to arise.

Work on the charge amplifier requires special equipment and service personnel trained by Kistler.
Zero shift and drift tests can be performed directly at the analog output pins with the voltmeter function of BioWare or a similar software package or with another voltmeter.

Always check the connecting cable and the data acquisition system are working perfectly (in relation to, for example, noise, drift and zero).

6.2 Weekly Function Check

The system check should be performed weekly.

6.2.1 System Check

Checking the system ensures that each channel of the force plate is outputting a signal that is correctly amplified in the charge amplifier and output to the data acquisition system.

The test is performed by just pushing on the force plate manually along the edges and on the corners.

6.2.2 Drift Check

Take a 30 second measurement of the unloaded force plate. Check drift of every channel to be within acceptable limits (see technical).

6.2.3 Check Gap Around Force Plate

Check the gap around the force plate with a piece of paper. If the gap is filled with dust or dirt there is a possibility for force shunt resulting in wrongly measured forces. To prevent small particles (sand, wear debris, etc.) getting trapped in the gap so they cause a force shunt, a gap width of 3 … 5 mm is recommended.

6.2.4 Setup Parameters

Regularly check if the force plate setup parameters in BioWare (or any other system used) comply with the force plate used.

- Sensitivity
  (see individual calibration sheet of the force plate according to serial number)
- Dimension
  (see operating instructions of the force plate)
- Position of force plates relative to each other
  (see BioWare instruction manual 2812A_002-312)

It is advisable to regularly check the charge amplifier for correct functioning.

6.3 Maintenance

The following points are to be noted concerning force plate maintenance:

- Always inspect your force plate for visible damage before using it. Do not put a damaged instrument into operation
- Leave all repairs (e.g. replacement of damaged plug and socket connections or defective sensors) to Kistler trained service personnel

6.4 Cleaning and Sterilization

In principle, because of the usual high temperatures sterilization of the force plate is not permissible. Instead of it we recommend the application of a mild, water-soluble cleansing or disinfecting agent (clinically tested) with a pH-value 6 ... 10, using a piece of cloth or sponge dampened with water.

Well suitable are various disinfectants usual in trade such as:

- EXTRAN® AP 43 of MERCK, product No. 7584, application in 0,3 % water solution at 40 °C for 15 min.
- RBS-25 of FLUKA CHEM. (about pH 10), product No. 83460; application in 2 (... 5) % water solution at 20 ... 40 °C for about 10 min.

Under no circumstances the force plate must be:

- sterilized in autoclave or steam
- dipped into a cleansing agent or cleaned in a liquid jet
- treated with a disinfectant on chlorine base (e.g. sodium hypochlorite

Extran® is a registered trademark of Merck KGaA, Darmstadt, Germany

7. Troubleshooting

Please refer to the instruction manual 002-034 "Force Plate Installation and Maintenance" for detailed procedures and information.

7.1 Defective Force Plate

Proceed as follows if your force plate is defective:

- Contact your Kistler distributor and advise him that you are sending in the defective instrument
- Send the defective force plate in its original packing to your Kistler distributor
- Give an exact description of the trouble and the accompanying circumstances together with the force plate
- Describe the measuring operation being performed when the fault occurred
- If a major repair is involved, you will receive a cost estimate
- Kistler will endeavor to repair your force plate as quickly as possible and at minimum cost, and to return it as good as new
- After any repair the force plate is recalibrated in the works

8. Technical Data

8.1 Dimensions and Connections

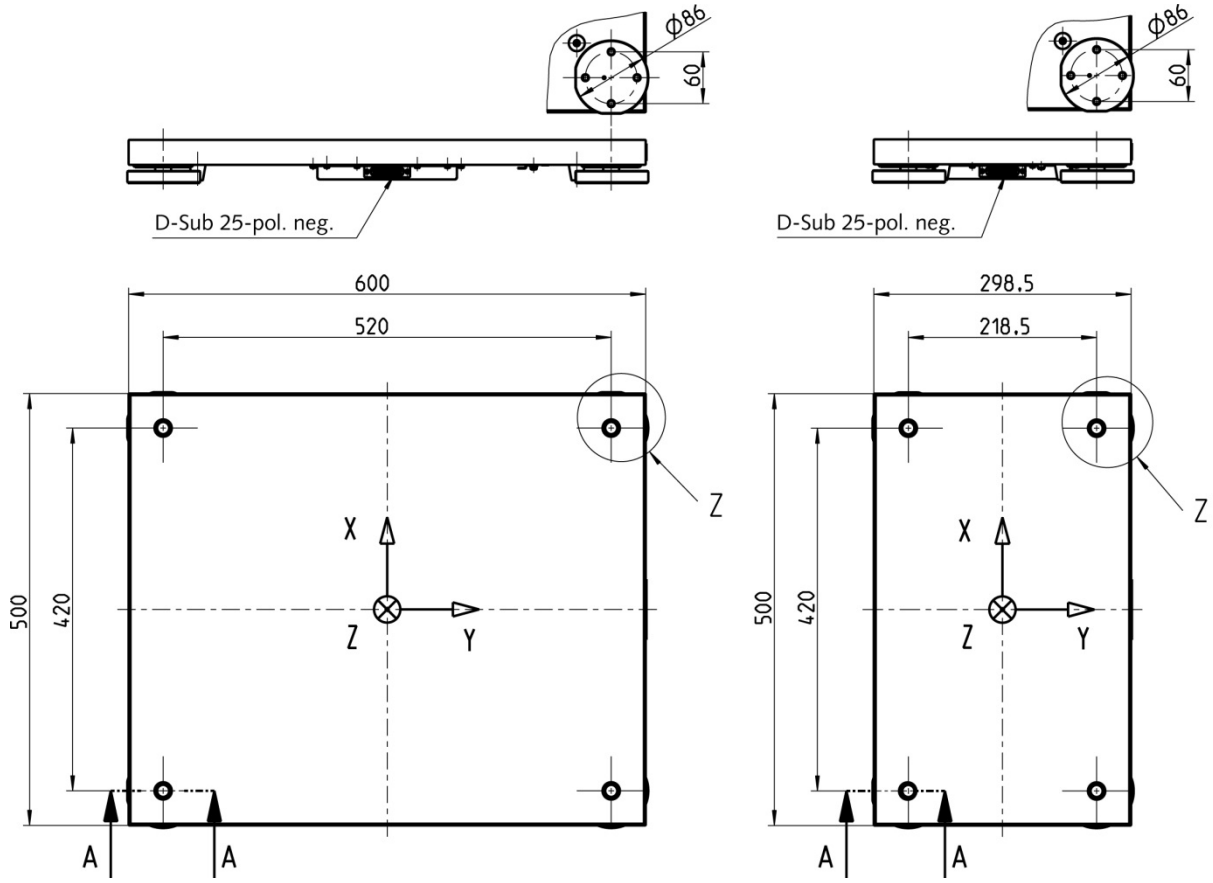


Fig. 16: Dimensions and connections of the multicomponent force plate Type 9260AA…

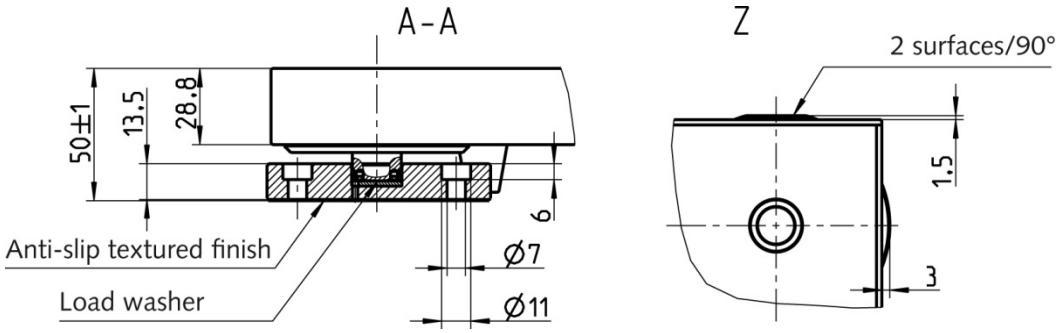


Fig. 17: Dimensions of the multicomponent force plate Type 9260AA…

8.2 Technical Data for Type 9260AA…

8.2.1 General

Measuring range	F_x, F_y F_z	kN kN	–2,5 … 2,5 0 … 5
Overload	F_x, F_y F_z	kN kN	–3/3 0/8
Linearity		%FSO	<±0,5
Hysteresis		%FSO	<0,5
Crosstalk	F_x <–> F_y F_x, F_y –> F_z F_z –> F_x, F_y	% % %	<±2,5 <±2,5 <±0,5
Max. COP error	a_x a_y	mm mm	≈2 ≈2
Natural frequency	f_n (x, y) f_n (z)	Hz Hz	≈400 ≈200
Operating temperature range		°C	10 … 50
Distance of surface of force plate from the x-, y-plane Distance of the axis of sensor from the y-axis Distance of the axis of sensor from the x-axis	a_{z0} a b	mm mm mm	–41 210 260
Weight Type 9260AA6 Type 9260AA3		kg kg	8,6 5,5
Degree of protection (EN60529:1992)			IP52
Calibrated partial range	F_x, F_y F_z	kN kN	0 … 0,25 0 … 1
Calibrated range	F_x, F_y F_z	kN kN	0 … 1,25 0 … 5
Sensitivity range 1	F_{xi}, F_{yi} F_{zi}	mV/N mV/N	≈37,5 ≈19,0
Sensitivity range 2	F_{xi}, F_{yi} F_{zi}	mV/N mV/N	≈7,5 ≈3,8
Sensitivity range 3	F_{xi}, F_{yi} F_{zi}	mV/N mV/N	≈3,8 ≈1,9
Sensitivity range 4	F_{xi}, F_{yi} F_{zi}	mV/N mV/N	≈1,9 ≈0,9
Ratio range 1:2:3:4			1:5:10:20[1)]

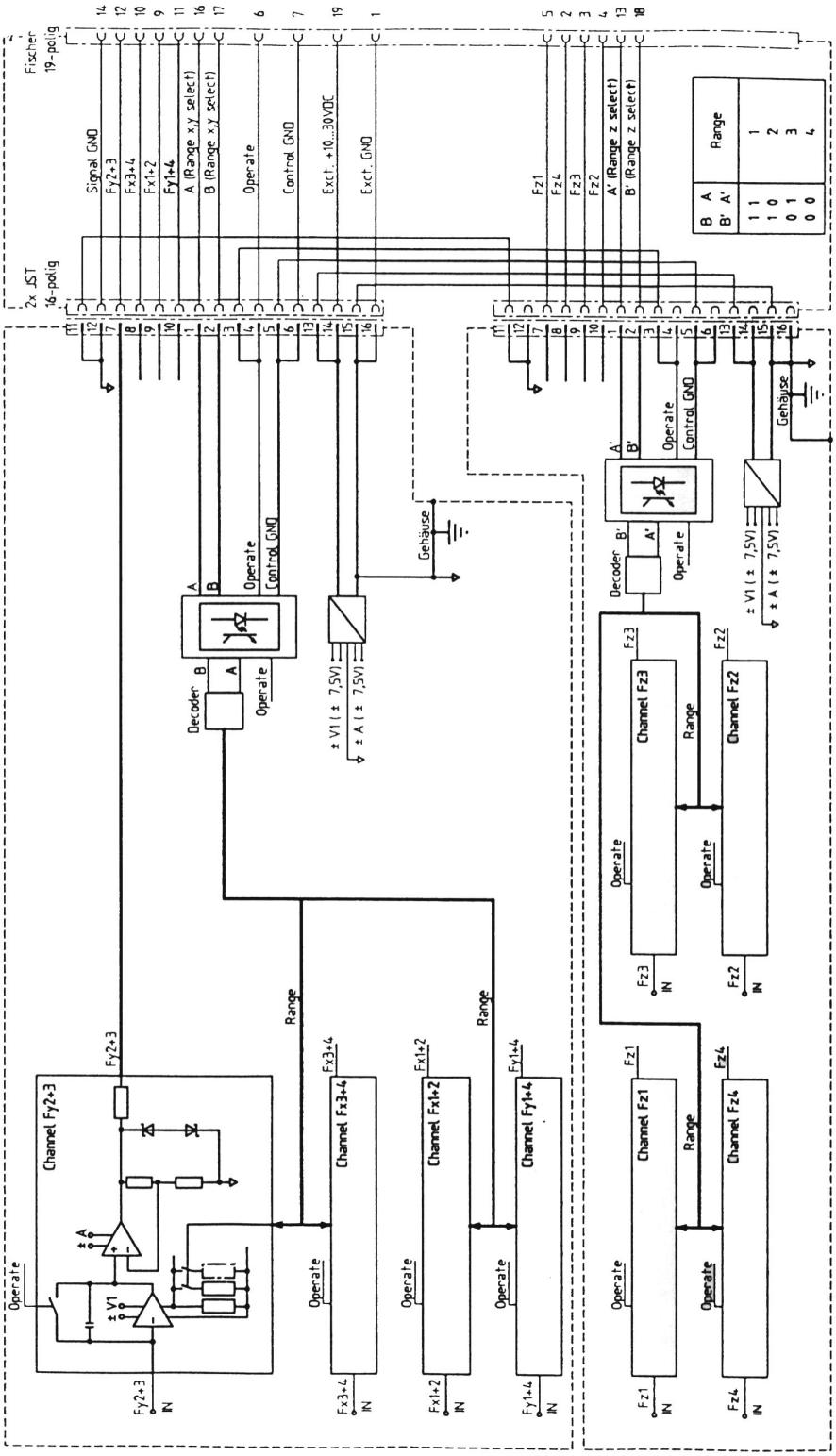
Threshold		mN	<250[2)]
Drift	F_x, F_y F_z	mN/s mN/s	<5 <10
Supply voltage		VDC	10 … 30
Supply current		mA	≈45
Output voltage		V	0 … ±5
Output current		mA	–2 … 2
Control inputs (optocoupler)		V mA	5 … 45 0,4 … 4,4

[1)] ±0,5 % accuracy

[2)] range 1 only

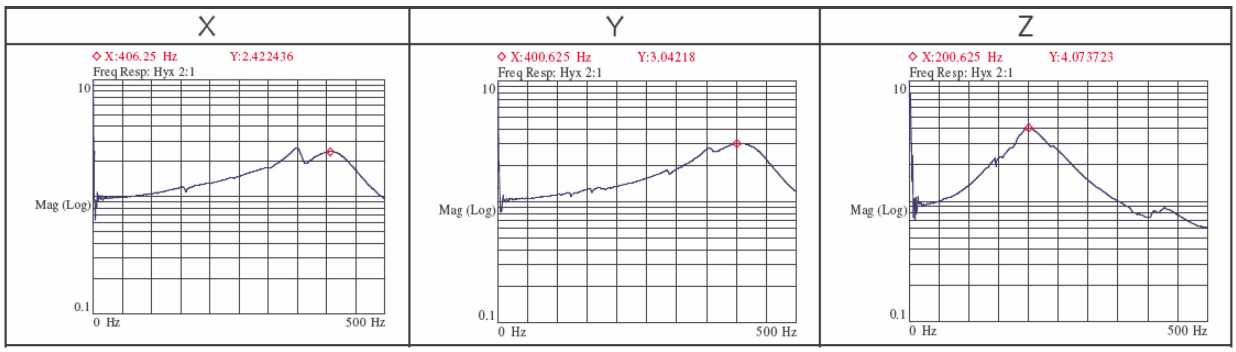
Conforms to the CE safety standards (73/23/EG) for electrical equipment and systems:
EN 60601-1:2005, EN 61010-1:2001
And the EMC standards (89/336/EG):
EN 60601-1:2005 (EN 55022 Class B), EN 61000-6-3:2004
(EN 55022 Class B), EN 61000-6-4:2001 (EN 55011 Class B),
EN 60601-1:2005, EN 61000-6-1:2001, EN 61000-6-2:2005.

8.2.2 Built-In 8 Channel Charge Amplifier



8.3 Frequency Response

Force plate loaded with 850 N



9. Glossary

9.1 Coordinate System

A positive Cartesian coordinate system is used as reference coordinate system.

There are two different coordinate systems in use.

In these operating instructions, the Kistler coordinate system is used exclusively.

9.2 Kistler Coordinate System

The following coordinate system is used for all Kistler force plates.

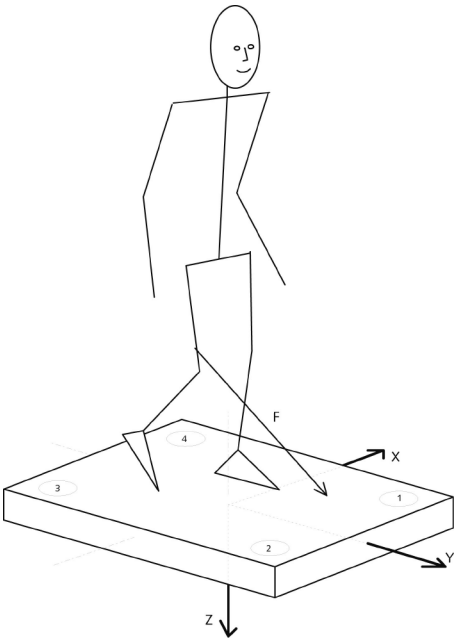


Fig. 18: Kistler coordinate system

9.2.1 ISB Coordinate System

The ISB (International Society of Biomechanics) proposes the following coordinate system.

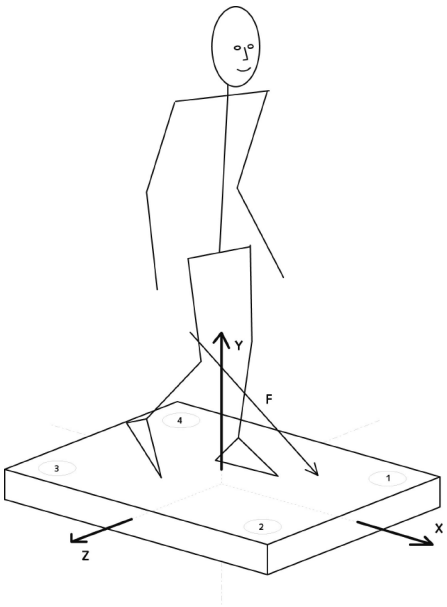


Fig. 19: ISB coordinate system

In the ISB-system not the active (acting) but counteracting (reacting) forces are described. The ISB coordinate system is used above all in connection with comprehensive movement analyses.

9.3 Parameters Calculation

Parameter	Calculation	Description
F_x	$= F_{x12} + F_{x34}$	Medio-lateral force [1]
F_y	$= F_{y14} + F_{y23}$	Anterior-posterior force [1]
F_z	$= F_{z1} + F_{z2} + F_{z3} + F_{z4}$	Vertical force
M_x	$= b \cdot (F_{z1} + F_{z2} - F_{z3} - F_{z4})$	Plate moment about x-axis
M_y	$= a \cdot (-F_{z1} + F_{z2} + F_{z3} - F_{z4})$	Plate moment about y-axis
M_z	$= b \cdot (-F_{x12} + F_{x34}) + a \cdot (F_{y14} - F_{y23})$	Plate moment about z-axis
M_x'	$= Mx + Fy \cdot a_{z0}$	Plate moment about top plate surface
M_y'	$= My - Fx \cdot a_{z0}$	Plate moment about top plate surface
a_x	$= (F_x \cdot a_{z0} - M_y) / F_z$	X-Coordinate of force application point (COP) [2]
a_y	$= (F_y \cdot a_{z0} + M_x) / F_z$	Y-Coordinate of force application point (COP) [2]
T_z	$= M_z - F_y \cdot a_x + F_x \cdot a_y$	Torque (free moment) about the vertical axis

[1] Walking direction is positive y-axis a, b and a^{z0} see technical data
[2] a^{z0} is a negative value

10. Warranty

Regarding the warranty reference is made to the agreement between the respective contracting parties.

11. Declaration of Conformity

KISTLER
measure. analyze. innovate.

EG-Konformitätserklärung

EC Declaration of conformity / Déclaration de conformité CE

Hersteller
Manufacturer / **Fabricant**

Kistler Instrumente AG
CH-8408 Winterthur

erklärt, dass das Produkt
declares that the product / **déclare que le produit**

Name / *Name* / Nom	**Biomechanical Force Plate Systems**
Typen / *Types* / Type	vgl. Seite 2 / see page 2 / voir page 2
Optionen / *Options* / Options	alle / all / toutes

mit den folgenden Normen übereinstimmt
relates with the following standards / **est conforme aux normes suivantes**

Sicherheit *Safety* / **Sécurité**	EN 60601-1:2005	**EN 61010-1:2001**
EMV Störaussendung *EMC Emission* / **Emission EMC**	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)**
EMV Störfestigkeit *EMC Immunity* / **Immunité EMC**	EN 60601-1:2005	**EN 61000-6-1:2001** **EN 61000-6-2:2005**

Gemäss den Bestimmungen der Richtlinien
following the provisions of directives / **conformément aux dispositions des directives**

73/23/EG (Sicherheit / *Safety* / Securité)

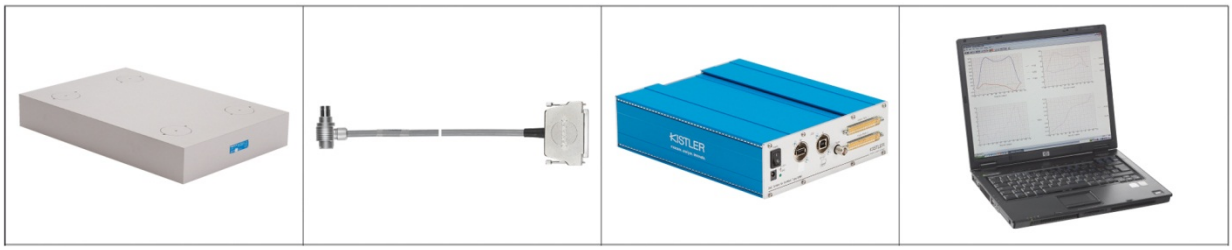
89/336/EG (EMV / *EMC* / EMC)

Winterthur, 21. April 2008

i.V.

i.V. D. Otter, Head of Development Electronics

KISTLER
measure. analyze. innovate.



With External Amplifier

Force Plate	Cable	Amplifier	Data Acquisition
Type 9281E	Type 1686A...	Type 9865E...	Type 5691A1 with cable Type 1769A or Type 2812A…
Type 9285	Type 1685B...		
Type 9286B	Type 1685B...		
Type 9287C	Type 1686A...		

With Built-In Amplifier

Force Plate	Cable	Amplifier	Data Acquisition
Type 9260AA	Type 1791A	(integrated in force plate)	Type 5691A1
Type 9281EA	Type 1759A...		
Type 9286BA	Type 1758A..., 1759A...		
Type 9287CA	Type 1759A...		

System Configuration without BioWare®

With Built-In Amplifier

Force Plate	Cable	Control Unit	Data Acquisition
Type 9281EA	Type 1757A...	Type 5233A2	customer specific
Type 9286BA	Type 1760A..., 1757A...		
Type 9287CA	Type 1757A...		