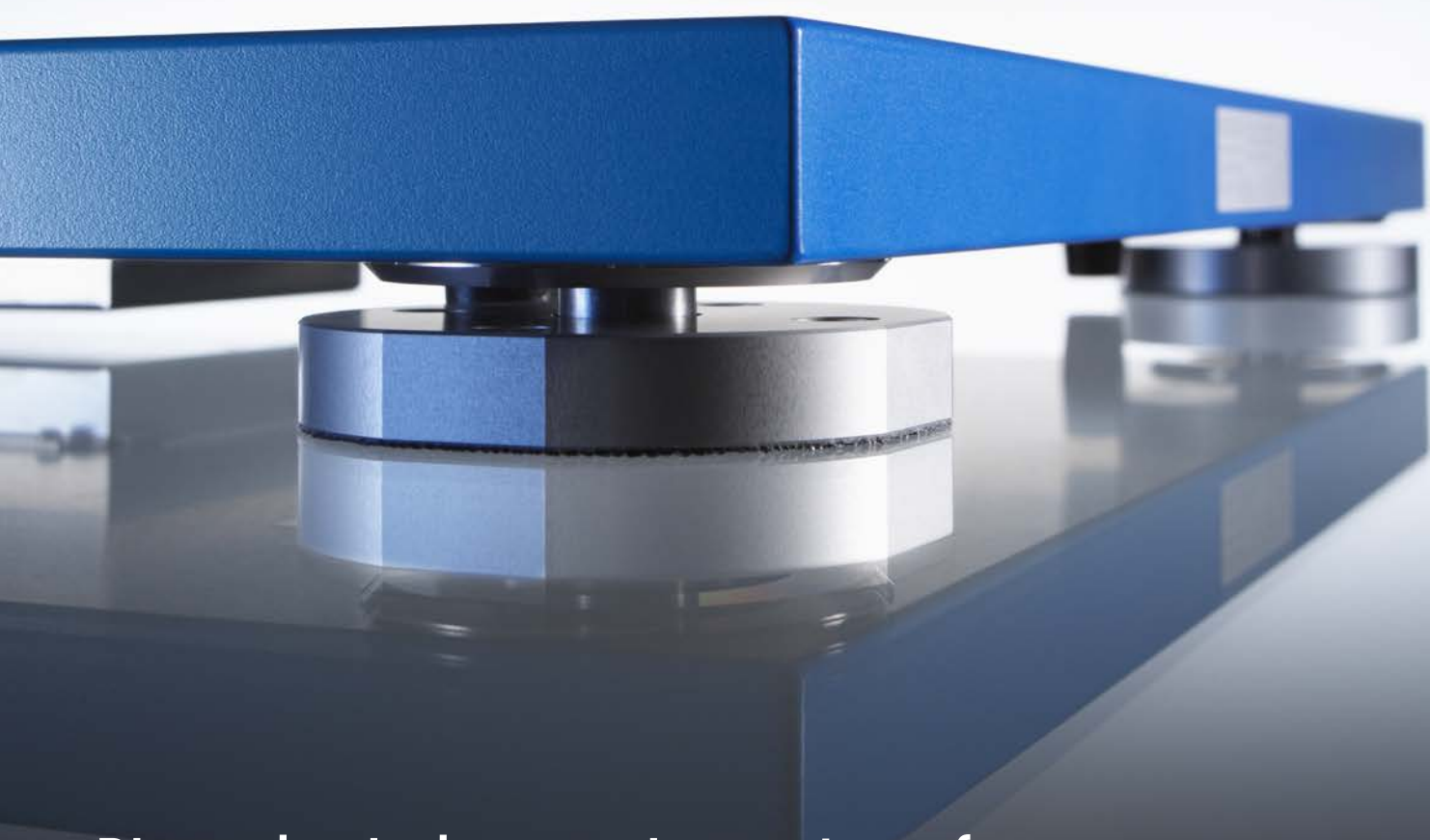


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# FORCE PLATES AND ACCESSORIES



Biomechanical measuring systems for  
performance diagnostics, gait analysis,  
rehabilitation and ergonomics

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# Improve movement, prevent injuries and boost performance

Targeted improvements to movement patterns and training routines demand in-depth knowledge of the sequence of movements and the related force progressions. Force plates with piezoelectric sensors from Kistler have been continuously refined over the last 50 years, and they are used with successful results in sport, rehabilitation, product ergonomics and clinical research.

Kistler offers a vast range of different force plates and systems that are as diverse as the application areas where they are deployed. Our measurement technology is used for many Olympic sporting disciplines, and it can be found on every continent – either as a single component or a complete turnkey system.

## Single components for many applications

- Permanently installed force plates with high natural frequency for outstanding accuracy
- Portable force plates for precise measurements and flexible usage
- Rugged, waterproof force plates for applications in humid/wet environments
- Force plates with a transparent cover plate, suitable for video recording from below in research and industry
- Instrumented pole vault planting box

## Sport-specific performance analysis systems

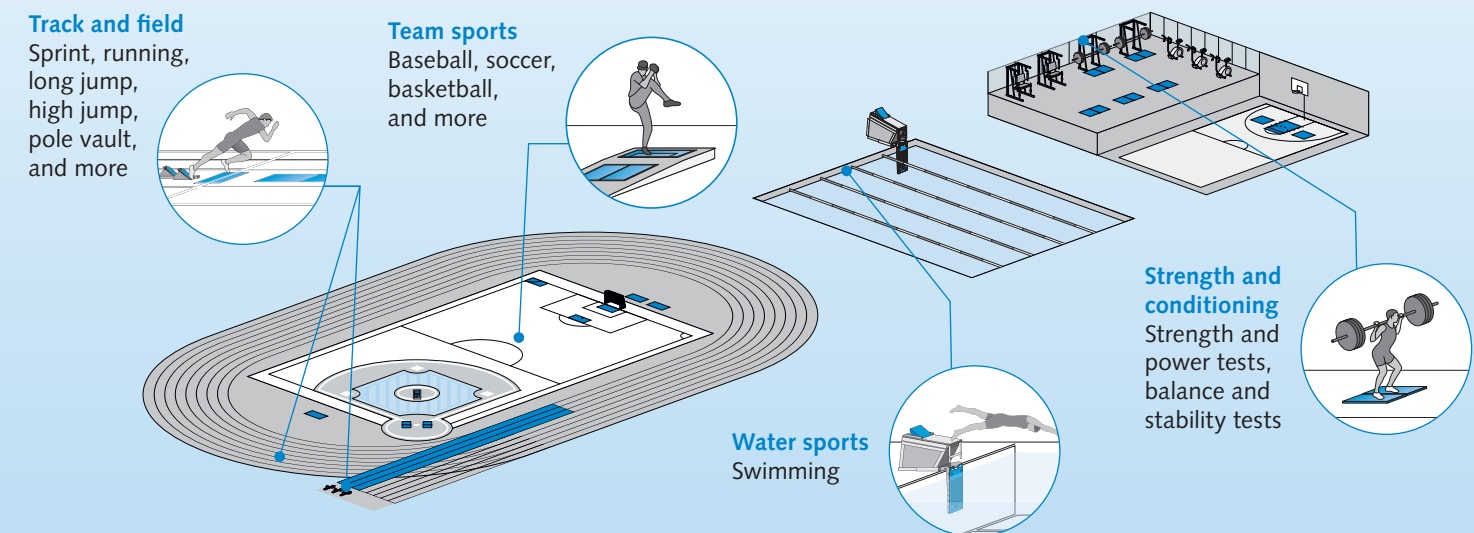
- KiJump & Quattro Jump systems for performance analysis and research in many sporting disciplines as well as strength and conditioning training
- KiSprint system for performance analysis during sprint starts
- KiSwim system for performance analysis of swimming starts and turning technique

Want to learn about the **benefits of piezoelectric sensor technology**? See page 20–21.

Visit [www.kistler.com/biomechanics](http://www.kistler.com/biomechanics) or take a look at our YouTube channel.



## Biomechanics systems – overview

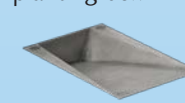


## Highlighted products

Instrumented sprint starting block



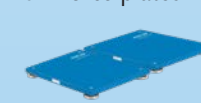
Sensor-equipped pole vault planting box



Instrumented swim starting block and turning plate



Lightweight and portable 3D force plates



Stationary force plates with high natural frequency



## Performance analysis systems, that make you win



**KiSwim system:** Swimming system consisting of an instrumented starting block, turning plate and multiple above- and underwater cameras. Analyze your athlete's start and turn in our unique software with direct feedback.

For more information, see page: 14



**KiSprint system:** Sprint system consisting of two instrumented starting blocks, a camera and a laser for speed measurement. KiSprint software provides insight into your sprinter's start.

For more information, see page: 15



**KiJump & Quattro Jump systems:** Movement analysis software that can be combined with 3D or 1D forceplates, and up to 2 cameras. Get more insight into your athlete's strength and conditioning performance.

For more information, see page: 16





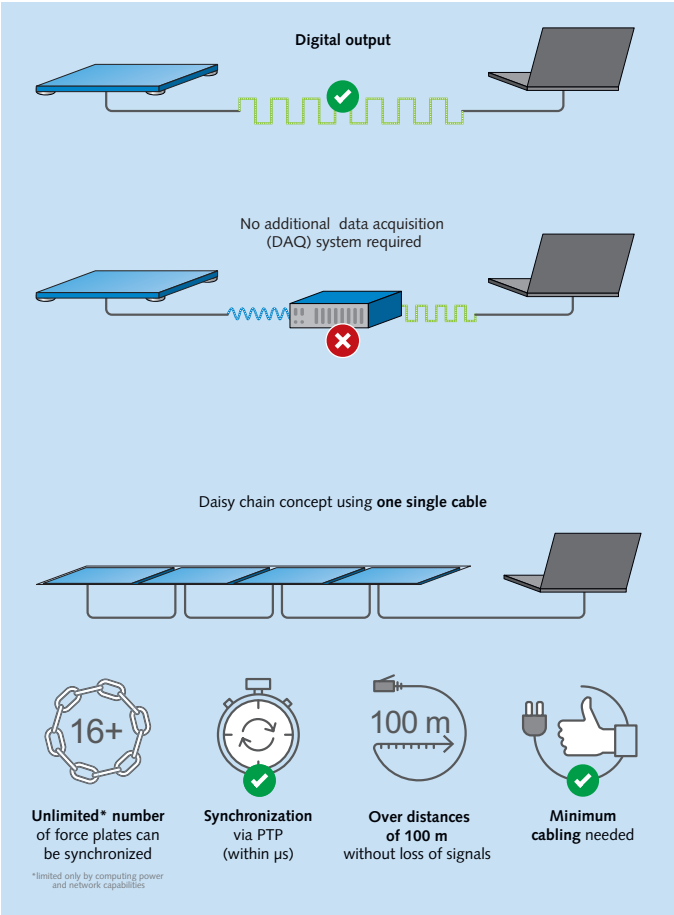
# The new gold standard from Kistler

The first cornerstone of the gold standard: technology that delivers absolute precision – the essential requirement for data that helps to optimize athletes' performance and to draw the right conclusions in gait analysis. Precision is also the basis for Kistler's standing as the global leader in dynamic measurement technology. Digitalization combined with over 50 years of Kistler's successful experience – a winning formula that yields multiple user benefits.

These are the assets you can expect when you go for Kistler's new gold standard in digital force measurement technology:

- Unbeatable precision and signal quality**
  - Highest measurement resolution in the biomechanics sector (24 bits data acquisition per channel)
  - Outstanding signal quality and low noise
  - PTP (Precision Time Protocol) synchronization within microseconds
  - High sample rates selectable
- Highly versatile**
  - Wide application range with only two measurement ranges (high and low)
  - Unlimited number of force plates can be synchronized, up to 16 digital force plates in one chain (daisy-chaining concept – multiple chains can be interlinked)
  - No loss of signal quality over distances up to 100 m

- Easy and fast setup of the digital force plates**
  - Plug-and-play saves time and effort
  - No separate data acquisition device required
  - Cabling is reduced to the absolute minimum
  - SDK interface (DataServer) for versatile integration into 3rd party systems


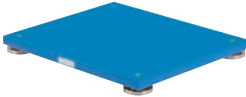




Visit our digital force plate technology website:



## 3D force plates for every application

Which force plate is best suited to your application?  
This page gives you an overview of the main force plates in Kistler's portfolio – and you'll find full technical details for all of them on the following pages.

Type	Dimensions mm	Measurement range, vertical kN							Weight kg	Analog or digital output	Natural frequency, vertical Hz	Pages
		-10	-5	0	5	10	15	20				
<b>Stationary</b> 	600×400×100								16	A or D	1000	8–9
	900×600×100								25	A or D	520	
	900×900×100								30	A or D	390	
	1200×600×100								28	A or D	520	
<b>Portable</b> 	600×500×50								8.6	A	200	10–11
	298.5×500×50								5.5	A	300	
	600×400×35								17.5	A	200	
	600×500×80								12.5	D	400	
	298.5×500×80								8.2	D	400	
<b>Glass</b> 	600×400×150								49	A or D	>500	12
	900×600×150								86	A or D	>200	
<b>Waterproof</b> 	600×400×100								40	A	850	13

### Renew your existing force plates



Lift your analog force plates to the next level by upgrading them to digital technology.

Benefit from all advantages of our gold standard digital force plate technology and make your measurement chain ready for the future. This allows you to enhance your force plate set-up and combine upgraded force plates with new devices.

Contact us for more details and to request an individual offer.







# 3D force plates for research and sport

**Application**  
This extremely versatile force plate is suitable for many applications, in fields such as research, gait analysis and sport.

**Key characteristics**  
Versatile force plate: up to 20 kN, lightweight construction, for dynamic measurements with outstanding measurement accuracy and high natural frequency.

## Analog output

Technical data							
	Type	9281EAQ10	9287CAQ10	9287CAQ01	9287CAQ02		
Dimensions							
LxWxH	mm	600x400x100	900x600x100	1 200x600x100	900x900x100		
Measurement range							
F <sub>x</sub> , F <sub>y</sub>	kN	-10 ... 10	-10 ... 10	-5 ... 5	-5 ... 5		
F <sub>z</sub>	kN	-10 ... 20	-10 ... 20	-10 ... 18	-10 ... 15		
Natural frequency							
f <sub>n(x,y)</sub>	Hz	≈1000	≈750	≈700	≈600		
f <sub>n(z)</sub>	Hz	≈1 000	≈520	≈520	≈390		
Weight	kg	16	25	28	30		

**Unlimited\* number**  
of force plates can  
be synchronized

\*limited only by computing power  
and network capabilities

**Synchronization**  
via PTP  
(within µs)

**Over distances**  
of 100 m  
without loss of signals

**Minimum**  
cabling needed

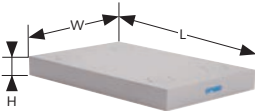
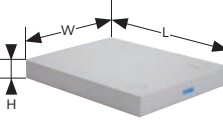
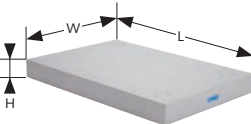
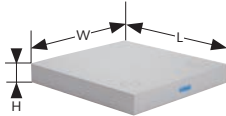
**No additional DAQ**  
required

**Upgrade to digital...**

**Or choose the digital gold standard from the beginning...**

And experience the matchless combination of Kistler's piezoelectric sensor expertise paired with the advantages coming with the digital measurement technology.

## Digital output

Technical data					
Type	9667AA0604	9667AA0906	9667AA1206	9667AA0909	
					
					
					
					
Dimensions					
L×W×H	mm	600×400×100	900×600×100	1 200×600×100	900×900×100
Measurement range					
F <sub>x</sub> , F <sub>y</sub>	kN	-10 ... 10	-10 ... 10	-5 ... 5	-5 ... 5
F <sub>z</sub>	kN	-10 ... 20	-10 ... 20	-10 ... 18	-10 ... 15
Natural frequency					
f <sub>n(x,y)</sub>	Hz	≈1000	≈750	≈700	≈600
f <sub>n(z)</sub>	Hz	≈1 000	≈520	≈520	≈390
Weight	kg	16	25	28	30





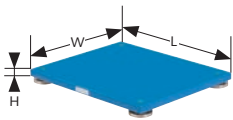
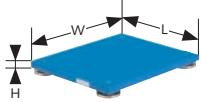
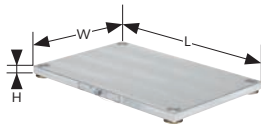
# Portable 3D force plates

**Application**  
 Type 9260AA can be used as a portable force plate on an existing flat base, and it can also be installed permanently in the floor at ground level. The modular system allows countless installation layouts. Force plates of this type with different dimensions can be combined as desired.

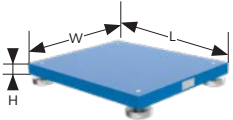
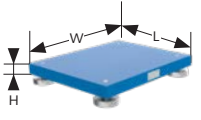
With a height of only 35 mm, force plate Type 9286 is extremely flat – and yet it features a wide measurement range of up to 10 kN and an excellent center of pressure (COP) accuracy. This model, featuring a rugged aluminum top plate, is excellent in gait analysis and is ideal for sports applications, particularly when ground-level floor installation is not feasible.

**Key characteristics**  
 Reasonably priced force plate with excellent accuracy for use in gait and balance analysis, and for performance analysis in sport. Simple to install, flexible and ideal for mobile use.

## Analog output

Technical data				
Type		9260AA6	9260AA3	9286BA
		  		
Dimensions				
L×W×H	mm	600×500×50	298.5×500×50	600×400×35
Measurement range				
F <sub>x</sub> , F <sub>y</sub>	kN	–2.5 ... 2.5	–2.5 ... 2.5	–2.5 ... 2.5
F <sub>z</sub>	kN	0 ... 5	0 ... 5	0 ... 10
Natural frequency				
f <sub>n(x,y)</sub>	Hz	≈400	≈500	≈350
f <sub>n(z)</sub>	Hz	≈200	≈300	≈200
Weight	kg	8.6	5.5	17.5

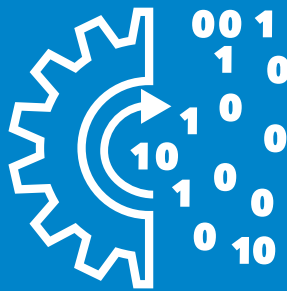
## Digital output

Technical data			
Type		9260BA6	9260BA3
			
Dimensions			
L×W×H	mm	600×500×80	298.5×500×80
Measurement range			
F <sub>x</sub> , F <sub>y</sub>	kN	–2.5 ... 2.5	–2.5 ... 2.5
F <sub>z</sub>	kN	0 ... 10	0 ... 10
Natural frequency			
f <sub>n(x,y)</sub>	Hz	≈400	≈400
f <sub>n(z)</sub>	Hz	≈400	≈400
Weight	kg	12.5	8.2

Upgrade to digital...

Or choose the digital gold standard from the beginning...

And experience the matchless combination of Kistler's piezoelectric sensor expertise paired with the advantages coming with the digital measurement technology.







# Force plates for special applications

## 3D force plates with glass cover plate

**Application**  
Force plates from Kistler with a glass cover plate feature a very large viewing window for photography and filming from below, while they still deliver highly accurate force measurements.

**Key characteristics**  
Force plate with glass cover plate for forces of up to 10 kN, to measure ground reaction forces, moments and the center of pressure (COP) in biomechanics.

## Analog output

Technical data					
Type		9285CA11	9285CA21	9285CA12	9285CA22
Dimensions					
LxWxH	mm	600x400x150	900x600x150	600x400x150	900x600x150
Measurement range					
F <sub>x</sub> , F <sub>y</sub>	kN	-2.5 ... 2.5	-5 ... 5	-2.5 ... 2.5	-5 ... 5
F <sub>z</sub>	kN	0 ... 10	0 ... 10	0 ... 10	0 ... 10
Weight		49	86	49	86

## Waterproof 3D force plate

**Application**  
Thanks to the aluminum top plate and a protective housing, this multicomponent force plate fulfills IP67 standards and provides high measurement accuracy and a wide measuring range, even under wet and harsh conditions.

Technical data		
Type		9253B11
Dimensions		
LxWxH	mm	600x400x100
Measurement range		
F <sub>x</sub>	kN	-10 ... 10
F <sub>y</sub>	kN	-10 ... 10
F <sub>z</sub>	kN	-10 ... 20
Natural frequency		
fn(x,y)	Hz	750
fn(z)	Hz	850
Weight	kg	40

**Key characteristics**  
Durable force plate with an IP67 rating and a high measuring range of up to 20 kN for applications which require robust measuring equipment.

## 3D instrumented pole vault planting box

**Application**  
A precise measurement of the force is possible immediately after the pole has been planted, thanks to the high natural frequency and rugged structural design of the planting box. Geometry and function match standard planting boxes.

Technical data		
Type		Z20903
Dimensions		
LxWxH	mm	1080x600x351
Measurement range		
F <sub>x</sub>	kN	-2.5 ... 2.5
F <sub>y</sub>	kN	-5 ... 5
F <sub>z</sub>	kN	-10 ... 10
Natural frequency		
fn(x,y)	Hz	≈400
fn(z)	Hz	≈400
Weight	kg	120

**Key characteristics**  
Force plate designed as an instrumented pole vault planting box to measure the forces exerted up to 5 kN, in the running direction.





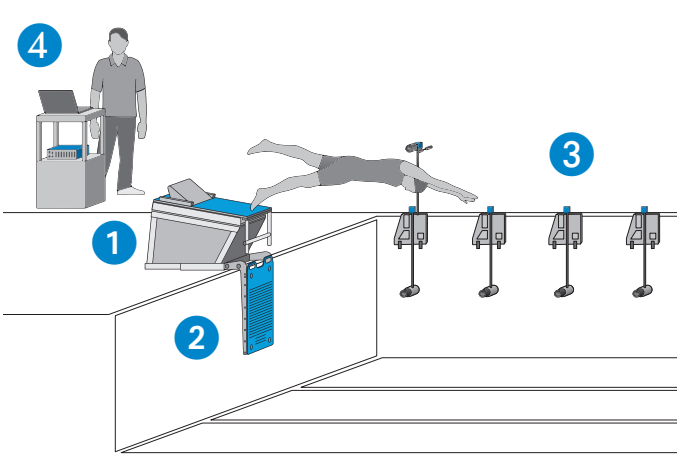
# KiSwim: optimize starts and turns with feedback training

KiSwim is a complete, portable system to execute a performance analysis for swimming. It is used for evaluation and targeted optimization of swimming starts and turns. The system combines force and speed measurement, high-speed video recording and software to analyze and compare multiple start attempts or different athletes.

The software of KiSwim records the data and immediately calculates the relevant parameters as well as numerous kinetic and kinematic key values that are then available to trainers and athletes as direct feedback training. The benefits: trainers and athletes can use the analyses of previous attempts to identify potential weak points in starting and turning technique – the basis for targeted performance improvements.

The starting block consists of 2 instrumented force plates, one for each foot (separate force measurement for the front and back foot). Additionally, an instrumented grab bar is installed in the starting block, allowing you to measure the grab force for a start on the block or during a backstroke start.

The instrumented turning plate allows the user to measure a backstroke start or a turn.



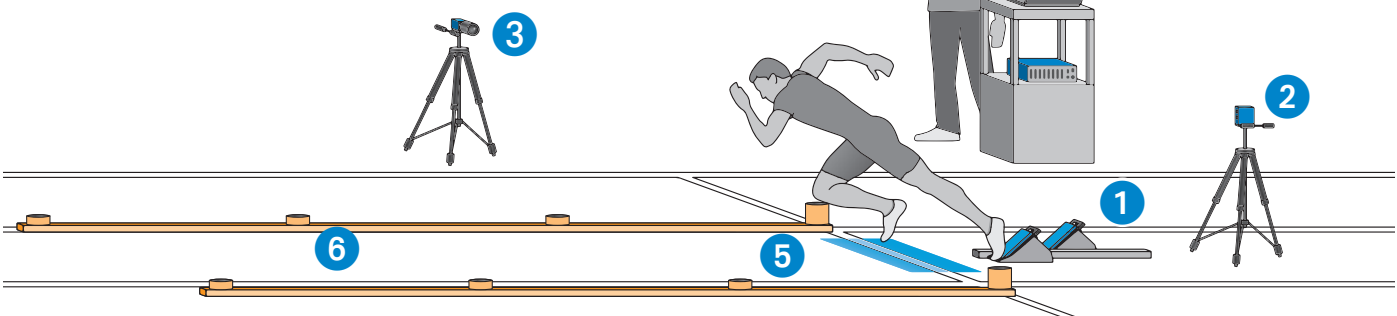
# KiSprint: optimize sprint starts with direct feedback

KiSprint is a portable, complete solution for wide-ranging performance analysis of sprint starts. The system comprises force and speed measurement, precise high-speed video recording and software to analyze and compare multiple start attempts or different athletes.

The software records the data and calculates the relevant parameters for sports scientists, trainers and the athletes themselves. The system immediately provides a clear and easily understandable display of the data – the basis for trainers to analyze and correct their athletes' sprint technique.

The KiSprint system consists of 2 instrumented starting blocks (force plates) for each foot (separate measurement for front and back foot), and accessories for optimal measurement of the sprint start.

- KiSprint system components**
- 1 Starting blocks with piezoelectric 3D sensors to measure sprint starts
  - 2 Laser distance measuring device to measure speed throughout the entire acceleration phase
  - 3 High-speed camera with tripod
  - 4 DAQ 5695B data acquisition system and KiSprint software
  - 5 Optional: force plates for hand force measurements
  - 6 Optional: Optojump Next from Microgate





# Quattro Jump: mobile performance analysis system for vertical jumps

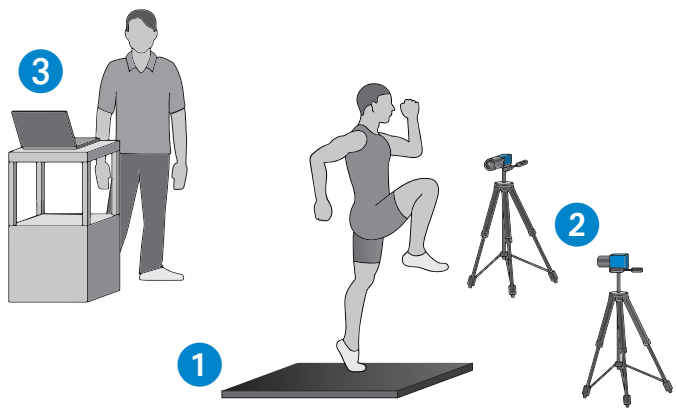
Quattro Jump, the turnkey portable performance analysis system, determines many relevant performance parameters for the lower extremities based on measurements of vertical force. Trainers and therapists can use this intuitive, user-friendly system to carry out efficient and extensive performance tests with large numbers of athletes – knowing that high accuracy and repeatability are guaranteed.

The force measurement can be synchronously acquired with high-speed cameras which record the execution of the movement. MARS software processes the data and generates a clear graphic display so that relevant parameters and performance development are immediately visible. Conclusions can be drawn from the tests about an athlete's state of fitness; this helps to improve training and recovery so that athletes can reach their individual performance goals more quickly.

The standard system comprises one portable force plate to perform jump tests. Optional cameras allow qualitative evaluation of the measured attempt and visualization of the measured forces.



Technical data				
Type	9290DD...			
Number of force dimensions				1
Dimensions	mm			920×920×125
Measurement range	F <sub>z</sub>	kN		0 ... 10
Natural frequency		Hz		≈150
Weight		kg		21.6
System				
Number of force plates				1
Number of high-speed cameras				1–2
DAQ required				No
Software	MARS Quattro Jump & KiJump			



- Quattro Jump system components**
- 1 Force plate with piezoelectric 1D sensors
  - 2 Up to two high-speed cameras with tripods
  - 3 MARS Quattro Jump & KiJump

# KiJump: mobile performance analysis system with 1D and 3D force plates

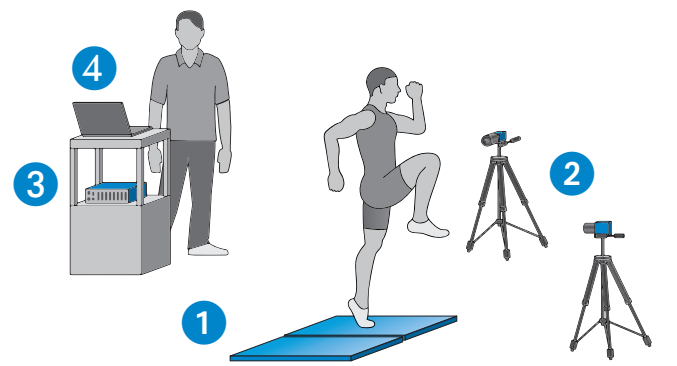
KiJump is a complete plug-and-play system for a variety of performance analyses, based on measurements of individual parameters such as jump force, speed, endurance, balance and stability. Trainers and therapists can use this system to carry out simple tests with high accuracy and repeatability.

High-speed video cameras record the execution of the movement synchronously with the force measurement. MARS software processes the data and generates a clear graphic display so that relevant parameters and performance development are immediately visible. By evaluating the results, conclusions can be drawn about the fitness of the athlete or patient, providing the basis for measures to prevent injuries and develop training plans.

**Choose the system that matches your requirements**  
Select a system with either 1D or 3D piezoelectric force sensors and choose the amount of force plates (up to two) suiting your application. Build, for example, a system comprising of two portable force plates for separate force analyses of both legs, as well as comparisons of the left and right legs. Cameras allow qualitative evaluation of the measured attempt and visualization of the measured forces. Force vectors directly integrated into the video image illustrate the size and direction of the measured force separately for each force plate.

Technical data	KiJump 3D	KiJump 1D
Type	On request	9229A...
Number of force dimensions	3	1
Dimensions	mm 600×500×50 298.5×500×50	600×500×65
Measurement range F <sub>x</sub> , F <sub>y</sub> , F <sub>z</sub>	kN –2.5 ... 2.5 0 ... 5	0 ... 5
Weight	kg 8.6 5.5	8

System		
Number of force plates	1–2	
Number of high-speed cameras	1–2	
DAQ required	Yes	No
Software	MARS Full, Power & Strength, Balance & Stability	MARS Quattro Jump & KiJump



- KiJump system components**
- 1 One or two force plates with piezoelectric 1D or 3D sensors
  - 2 Up to two high-speed cameras with tripods
  - 3 Data acquisition system: DAQ 5691A or 5695B (only with 3D version)
  - 4 MARS Full, Power & Strength, Balance & Stability or Quattro Jump & KiJump





## Performance analysis with Kistler MARS software

**MARS stands for Measurement, Analysis, and Reporting Software from Kistler – the versatile solution designed for performance analysis in sport and rehabilitation. This unique analytical software for force plates from Kistler rapidly generates targeted evaluations of standardized movement sequences, helping you to continue and optimize your athletes' development according to each individual's performance levels, by providing you objective information about the performance of each subject.**

### User-friendly evaluation of complex movement sequences

MARS software analyzes the signals from the force plates, calculates all the relevant performance parameters and generates a graphic display of the measurement data. Analyses and calculated parameters are ready to be reviewed almost immediately – thanks to 25 predefined test modules for standardized movement sequence tests. These tests deliver detailed analysis of movement sequences that are typical for the human body: static and dynamic balance, gait analysis and rapidly alternating movement progressions, as well as strength and power (in relation to all vertical jumps). The data is stored in a database where it is available for generating comparisons and reports.

### Compatible measurement systems

MARS software can operate with all Kistler's analog and digital force plates. Additionally, MARS is also compatible with Kistler's 1D KiJump and 1D QuattroJump force plates.

### Benefits of MARS software

- Fast comparisons of application-specific performance parameters
- 25 different evaluation modules
- Unilateral and bilateral analysis
- Comparison mode to compare different athletes or different trials
- Visual feedback thanks to synchronized video recording with force vector overlay

### Different versions of MARS available, suiting different wishes:

#### Full version

##### Power & Strength <sup>3D</sup>

- Vertical jump
- Sideways jump
- Fast alternating movements

14 modules to analyze power and strength in sport

##### Balance & Stability <sup>3D</sup>

- Dynamic and static balance
- Locomotion and body transfer

11 modules to analyze balance and stability in rehabilitation and research

##### Quattro Jump & KiJump <sup>1D</sup>

- Vertical jump
- Fast alternating movements

11 modules to analyze power and strength

## BioWare software

BioWare software for data acquisition from force plates

### Type 2812A

BioWare is a high-performance software for data acquisition and signal conditioning, used with force plates and other similar devices: for display, analysis, statistics, filtering, export, etc. This software is designed for work with Kistler force plates in biomechanics; it allows synchronous data acquisition and full utilization of the force plates' capacity. BioWare calculates specific parameters such as forces, moments or centers of pressure (COPs) and enables comprehensive digital signal conditioning, e.g. with freely definable digital filters, resampling, frequency analysis or FFT, etc.

### Supported types of data acquisition

- Type 5691A – data acquisition system for up to two force plates
- Type 5695B – data acquisition system for up to eight force plates, with sync I/O
- Digital force plates – measure with your digital force plates directly in Bioware

BioWare DataServer API (dataserver.dll)

### Type 2873A

The data server programming interface [dataserver.dll] is a Microsoft Component Object Model in-process server. Microsoft Component Object Model (COM) is a software architecture that ensures that components are interoperable in multiple software programming languages (C++, Visual Basic, Java, etc.) by making a binary standard available for component development.

The DataServer interface library gives third-party system integrators a simple yet versatile interface with data from our analog force plates, via the type 5691A and type 5695B data acquisition systems, or directly from our digital force plates. DataServer COM components control and manage the force plates and additional equipment; they also provide the typical data flows calculated via the force plates. The aim is to provide external system integrators with a simple XML configuration file so that internal data acquisition and calculations can then be used with any desired COM-compatible language.

**Bioware software and Bioware DataServer can be downloaded free of charge at [www.kistler.com](http://www.kistler.com)**






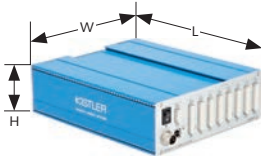
# Accessories for analog force plates

## Data acquisition systems

**Application**  
The versatile, high-performance DAQ system can be used with the BioWare data acquisition software or the Kistler MARS performance analysis software, according to choice. It is also supported by software products from many third-party suppliers.





**Key characteristics**  
USB data acquisition system for collecting high--performance data and supporting signal conditioning for Kistler force plates or other analog signals. Extensive range of triggering and synchronization options.





### Data acquisition system




Technical data	Type	5691A...	5695B...
<div><div></div><div></div></div>			
AD conversion			
Number of channels		16	64
Resolution (per channel)	bits	16	16
Max. sampling rate (all channels)	S/s	9 500	10 000
Control I/O		External trigger	Trigger Input/Output, Sync Input/Output, Sampling Clock Output, Reserve Output
Control I/O connection		BNC female	D-Sub 9 female
Force plate		1 ... 2	1 ... 8
Force plate connection		D-Sub 37, male	D-Sub 25, female
Analog outputs		–	For all signals
Connections		USB 2.0	USB 2.0
USB In (uplink, to PC)		USB type B, female	USB type B, female
USB Out (downlink, free)		USB type A, female	
Dimensions			
LxWxH	mm	250x208x65	265x208x70

**Further options for your measuring chain**  
If these data acquisition systems and cables do not fit your individual needs or if you have other requirements for the set-up of your measuring chain, contact us and we will find the right solution for you.



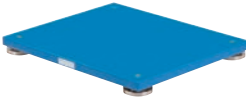



## Cables

Technical data	Type	1757A...	1758A...	1759A...	1760A...
<div></div>					
Connection		Fischer angle connector 19-pin, male – MIL 19-pin, male	Fischer connector 19-pin, male – D-Sub 37-pin, female	Fischer angle connector 19-pin, male – D-Sub 37-pin, female	Fischer connector 19-pin, male – MIL 19-pin, male
Length	m	10/sp (max. 30)	10/sp (max. 30)	10/sp (max. 30)	10/sp (max. 30)

Technical data	Type	1700A105A...	1700A105B...	1700A107A...	1700A109A...
<div></div>					
Connection		Fischer angle connector 19-pin, male – D-Sub 25-pin, male	Fischer connector 19-pin, male – D-Sub 25-pin, male	D-Sub 25-pin, male – D-Sub 25-pin, male	D-Sub 37-pin, male – D-Sub 25-pin, male
Length	m	10/sp (max. 30)	10/sp	10/sp	2/sp

Technical data	Type	1791A...	1793A...	5767
<div></div>				
Connection		D-Sub 25-pin, male – D-Sub 37-pin, female	D-Sub 25-pin, male – MIL 19-pin, male	D-Sub 9-pin, male – BNC, female
Length	m	10/sp	10/sp	0.4

## Measuring chain for analog force plates


Accessory / type	9281EAQ10 9287CAQ...	9260AA...	9286BA	9285CA11, 9285CA21
<div></div>				
With integrated charge amplifier				
 5691A	1759A	1791A	1758A	1758A
 5695B	1700A105A	1700A107A	1700A105B	1700A105B

# Accessories for digital force plates





## Sync Box

**Application**  
This accessory for your digital measuring chain adds a versatile trigger and synchronization interface which can be seamlessly integrated into the daisy chain and offers all benefits of our digital measuring technology such as PTP synchronization and easy cabling.

**Key characteristics**  
The digital Sync Box Type 5699A offers a BNC port which can be configured as Trigger In or Trigger Out and provides a connection to synchronize with other measuring equipment.

Technical data	Type	5699A
		
Connections		
Number of channels		1
Connector		BNC negative
Trigger Output		
Type	Open-collector with internal pull-up	
High-level output voltage typ. @ I <sub>out</sub> = 0A	V	5
Low-level output voltage	V	<0,2
Trigger Input		
Input voltage range max.	V	-2...7
High-level input voltage	V	>2,1
Low-level input voltage	V	<0,5
Dimensions		
LxWxH	mm	164x111x45

## Cables

Technical data	Type	1200A263AMAM	1200A263AMSM	1200A263AMSF	5793A
					
Connection		M12 angled male – M12 angled male	M12 angled male – M12 straight male	M12 angled male – M12 straight female	M12 straight male
Length		2/5/10	10/15/20/25/30/35	2/10/20/30/40	approx. 1.5

## Measuring chain for digital force plates

- How to build your digital measuring chain:**
- Connect up to 16 devices in one daisy chain
  - All types of digital force plates and analog force plates which have been upgraded to digital can be combined
  - One power and ethernet supply set 5793A is required per daisy chain
  - Multiple daisy chains can be PTP synchronized when connected to a PTP switch
  - Use cable type 1200A263AMAM for daisy chaining of force plates
  - Cable type 1200A263AMSM connects force plate to sync box
  - At the end of each daisy chain a cable of type 1200A263AMSF is required which fits to the connector of the power/ethernet supply set

## Example of a measuring chain





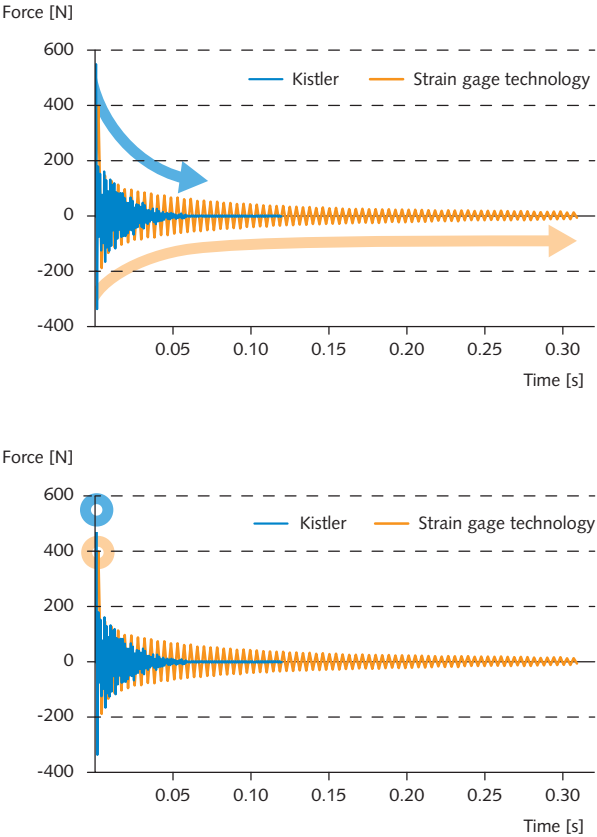
# Piezoelectric measurement technology

**What makes piezoelectric measurement technology superior to strain gage technology for measuring dynamic forces?**  
Force plates from Kistler are equipped with small, rigid piezoelectric force sensors – the leading technology for measuring dynamic forces. They have exceptionally high natural frequencies in both the vertical and shear directions. In addition, they feature an outstanding dynamic impulse response and a very wide measurement range with high resolution.

**Why is the impulse response of a force plate so important?**  
The way a force plate reacts to abrupt changes in forces is a critical factor in the accuracy of the measurements. High damping plays a key part when forces that change suddenly are involved – as is usually the case in biomechanics. Outstanding impulse response is a distinguishing feature of force plates from Kistler. This means that if an event is followed by an abrupt action that has a big impact (like for example placing and lifting the foot on the ground during running), this can be recorded far more accurately with piezoelectric force plates than with force plates based on strain gages.

Benefits of our force plates

- Very precise measurement of highly dynamic force impact thanks to high natural frequency and good damping behavior
- Extremely wide measurement range: one single force plate can measure both small and large forces with consistent accuracy, and can capture the most extreme force peaks with maximum resolution. The benefit: one and the same force plate can be used in a vast range of different applications
- Exceptionally cost-efficient: no fatigue, even after millions of loading sequences and many temperature cycles
- No damage due to overload



**Why is a high natural frequency so important?**  
In biomechanical tests, the force often increases at quite a high rate. A force plate with a high natural frequency is therefore essential in order to obtain accurate measurement results. A high natural frequency results in a high maximum measurement frequency – an essential requirement for accurate measurements of highly dynamic movement sequences. Because of their higher natural frequency, piezoelectric force plates can measure dynamic movement sequences better, as they provide more reliable values (e.g. for peak forces, rate of force development) than strain gage force plates.

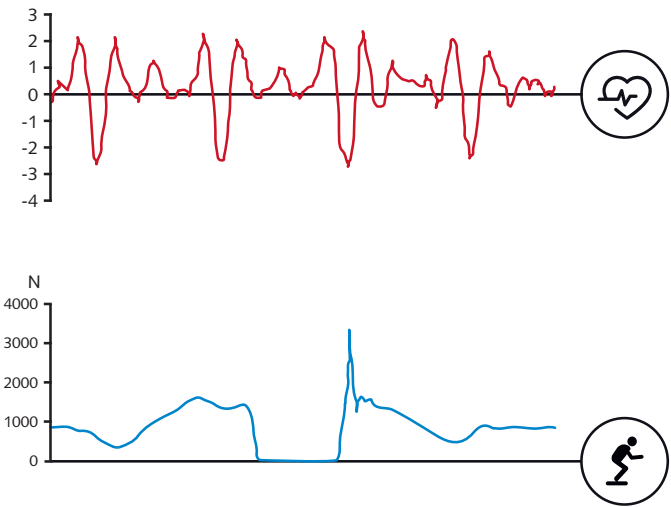
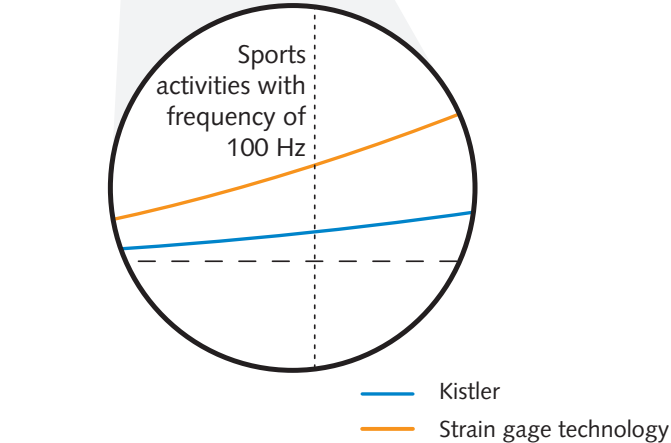
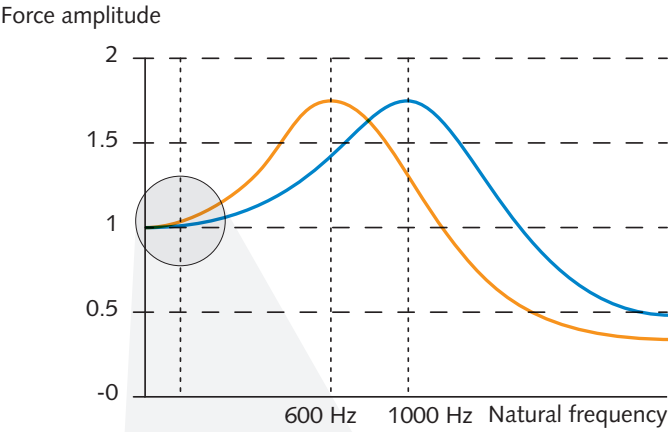
A high natural frequency also has a very beneficial effect on measurements of sports activities with low frequency content. A greater difference between the natural frequency of a force plate and the frequency content of the movement reduces the overstatement of the measurement frequency. Due to this high natural frequency the measurement error will be reduced.

**In which range should the natural frequency of my force plate be?**  
We recommend using a force plate with a natural frequency that is at least 5–10 times greater than the largest frequency component of the signal. Above this value, the force amplitude is falsified by the overstatement of the natural frequency, leading to errors in the signal. A standard gait analysis involves frequencies of up to 50 Hz – more dynamic tests such as jump or sprint analyses may include frequencies of up to 100 Hz or even higher. The natural frequency must therefore be as high as possible so that you can record the frequencies that interest you with maximum precision. Force plates from Kistler have natural frequencies of up to 1 000 Hz in the horizontal and shearing directions.

**What happens if my force plate has a low natural frequency?**  
The lower the natural frequency of the force plate, the more it approaches the frequency content of the movement. The result: the data you obtain is overstated due to the natural frequency, so it is inaccurate.

**Why can piezoelectric force plates be used more flexibly?**  
A piezoelectric force plate has very high sensitivity across a wide measurement range. In piezoelectric sensors, sensitivity and resolution are independent of the sensor itself, the measurement range and the size of the sensor. This means that sensitivity is greater and resolution is better throughout the entire measurement range.

Users of force plates based on strain gage sensors must choose a specific force plate that is suitable for the particular measurement range. Exceeding this range usually results in damage to the structure of the strain gage sensor. Force plates based on strain gage sensors that are exposed to large forces will not generate signals of adequate quality anymore when they are subjected to lower loads. Piezoelectric force plates don't have this issue as the sensor can't be damaged by overload.



At a glance

- Cutting-edge technology to measure rapidly changing forces and force peaks thanks to the force plate's excellent dynamic response
- Accurate measurements of impacts and force peaks thanks to high natural frequency
- Extremely wide dynamic measurement range with high resolution thanks to piezoelectric technology
- One single force plate covers a vast range of different applications
- Sensors benefit from excellent overload protection and virtually unlimited lifetimes (constant unimpaired sensitivity)

# Versatile installation options for every application

Kistler offers a wide-ranging portfolio of accessories to ensure flexible installation of its force measurement systems in line with individual user requirements. They can be mounted in any desired position and equipped with additional devices or coverings – without affecting their zero point or precision.

Versatility is a hallmark of Kistler force plates: depending on their maximum loading capacity and natural frequency, they can be used flexibly in a diverse range of applications. Mobile force plates offer maximum flexibility, while fixed-installation models are ideal for highly dynamic measurements.

### Mobile use for maximum flexibility

Customers who need the versatility of mobile use are best to choose force plates that do not need to be mounted on a frame: instead, these models can be operated easily on any flat surface – so costs are cut. Multiple mobile force plates (even of different sizes) can be assembled to create walkways. Kistler offers matching modular accessories for this purpose.

### Fixed installation for dynamic applications

For highly dynamic applications, our force plates are mounted on an installation frame that is cast permanently in the foundation to ensure full exploitation of the plates' potential. A lightweight aluminum sandwich cover plate keeps the weight of the platforms themselves to a minimum. This makes it easier to mount and transport Kistler force plates, so they can be used in a variety of installed positions – and also at different measuring stations.

### Connection technology for optimum data quality

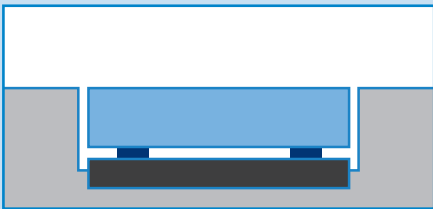
Kistler's connection technology is optimized for use in biomechanics and sports applications. High-quality cables are fitted with solid connectors. Many Kistler force plates can be used safely in the open air.

## Mounting options

Kistler offers solutions for every installation requirement. These specific examples show the installation options that are available – and their benefits.

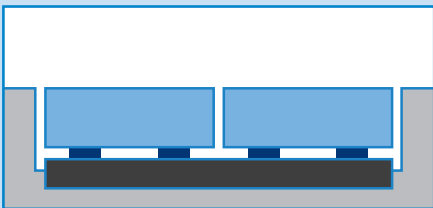
### Installation with frame

A mounting frame is an excellent choice for the permanent installation of a force plate. The frame is casted to the foundation, using non-shrink epoxy resin. The force plate is fixed onto the frame with a bolted connector.



### Installation with multiple frame

Kistler offers multiple frames to install several force plates. These frames allow different mounting positions so the layout can be adapted to your individual needs. Multiple frames cut down the installation outlay when several force plates need to be mounted.



### Installation with anchors

Installation with anchors is suitable if it is not possible to provide a large recess for frame mounting. The anchors only need small holes to be drilled into the foundation. This method is also suitable for vertical installation of force plates.



# Achieve perfect accuracy with comprehensive services

## Support that suits your needs

Whether you need advice, support with an installation or calibration – our experienced biomechanics team is standing by to advise and assist you.

### Comprehensive range of services

In addition to high-quality sensors and systems, Kistler offers a host of services – from professional advice and installation support to speedy worldwide deliveries of spare parts. For an overview of the services we offer, visit: [www.kistler.com/service](http://www.kistler.com/service)

#### Kistler services at a glance

- Advisory support
- Installation
- Commissioning support
- Periodic calibration
- Training courses/workshops

### Calibration process

Calibration of a sensor is carried out by comparing its output signal with the signal from a reference sensor. The precise sensitivity of the reference sensor is known and can be traced back to the national standard on the basis of the calibration hierarchy. Kistler uses the continuous method for calibrating piezoelectric sensors. With this method, the load is continuously increased to the required value within a defined time and then reduced to zero again within the same time. The resultant characteristic, which is never exactly linear, is approximated by a "best straight line" that passes through the origin. The gradient of the straight lines corresponds to the sensitivity of the sensor in the calibrated measurement range.

### EOL calibration

An EOL (End-of-Line) calibration is carried out on every sensor in the Kistler Production Center as the standard calibration during final acceptance testing prior to delivery of the product. The calibration results for each individual sensor are stored during this process. A calibration certificate is enclosed with most sensors on delivery.

### Recalibration

Regular recalibration is recommended in order to guarantee measuring accuracy throughout the entire lifetimes of Kistler's sensors and equipment, and to meet the highest quality assurance criteria. Recalibration is a standard calibration process based on the EOL calibration.

## Your accredited partner for calibration

### Calibration service from Kistler

Sensors and measuring instruments must be calibrated at regular intervals because their characteristics can change over time due to use, aging and environmental factors. Instruments used for calibration at Kistler are traceable to national standards and subject to uniform international quality control. Calibration certificates document measured calibration values and conditions.



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