Technical Data
and
Instructions for Use

FDM SYSTEM

zebris

zebris Medical GmbH REF 79010105 Text-Release: 01/09/2026

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Hardware Instructions for Use FDM-System

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Illustrations of this manual may differ.

Please always provide the serial number of the product for inquiries!

CE 2797

1 User information

1.1 Composition of the Instructions for Use

The FDM-System consists of the force distribution measuring sensor technology as well as the corresponding application software including a PC.

Therefore, the user manual of the FDM-System consists of several parts:

1. FDM technical specifications and Instructions for Use
2. User manual for the zebris FDM application software
3. User manual of the components, like e.g., projector or PC

NOTE

Please closely observe the user manuals with initial operation, use or maintenance as well as transport of the FDM-System.

The section FDM technical specifications and user manual primarily contains information on technical data and the operation of the FDM-System sensor technology as well as on their safe operation.

The software and hardware operating instructions can be displayed in the software as online help (F1 key).

In addition, the documents are available on the enclosed installation data carrier and on-line at https://www.zebris.de/en/info-menu/downloads/

WARNING

Read these instructions carefully before using the product for the first time to avoid operating errors and damage.

The exact adherence to all parts of the operating Instructions for the FDM-System is a precondition for its intended use.

1.2 Symbols used on product, packaging and Instructions for Use

WARNING symbols indicate a potential hazard to the health and safety of the users and/or patients. The warnings describe the risks involved and those can be avoided.

NOTE symbols indicate a potential risk which could lead to damaging of the device. These NOTE symbols describe the risks involved and how those can be avoided.

CE mark according to EC directive 93/42 Medical devices

Manufacturer

Manufacturing Date

Device of type BF according to DIN EN 60601-1

Direct Current

USB-Interface

Do not dispose of with household waste

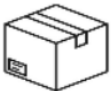
Refer to instructions for use.

Observe instructions for use

Item Number

Serial Number

Medical Device



Packaging REF acc. to PPWR

US Federal law restricts this device to sale by or on the order of a physican or proffesionel user

UDI with HIBC-Code

Swiss authorised representative

2 Scope and security

2.1 Intended Use

Main function of the force distribution measurement system FDM is the spatially resolved force distribution measurement under human feet for the analysis of static and dynamic strains as well as the individual gait parameters.

Operation as well as data evaluation and storage are software-aided by using a computer. The FDM-System are suitable for the use with patients that are mentally capable of following the operator's instructions without limitations in the period of application.

Professional facilities (medical practices, clinics, scientific institutions, rehabilitation centres, and orthopaedic specialist shops) are specified as application environment.

The application and operation of the system may only be carried out by thoroughly trained qualified personnel such as clinical doctors, physiotherapists, orthopedics which possess the ability to evaluate the output data in medical aspects as an aid for the diagnosis, treatment or patient care and considering the clinical history of the patient in the context of other diagnostic tests.

2.1.1 Indications

- Stance and gait analysis of the "normal" as well as the pathological stance and gait.
- Diagnosis support with foot malposition's and foot corrections
- Diagnosis support and therapy of imbalances / incorrect gait pattern
- Detection of inappropriate mechanical stress and overstraining for the prevention of physical problems and for rehabilitation with disabilities after injury, accidents, or surgeries.
- Support with the development, adjustment, and verification of orthopaedic aids for the individual patient care
- Balance analysis and balance training
- Gait training in combination with dynamic visual stimulation (cueing) and feedback training as therapy/rehabilitation measures after a surgery, stroke, with the Parkinson's disease as well as other neurologic and orthopaedic disorders
- Success control of therapy/rehabilitation measures

2.1.2 Contraindications

- The FDM system must not be applied for a barefoot measurement with patients having open wounds and/or infections on the feet.

2.1.3 Product life

Provided that the Software and the operating system of the measurement PC are kept up to date, a product life of 10 years can be expected.

2.2 Safety

2.2.1 Environmental conditions

FDM-System are suitable for application in dry interiors with level ground such as those in hospitals, doctors' surgeries, and laboratories.

Temperature	10°C to 40°C
Relative humidity	30% to 70%, non-condensing
Air pressure	700 to 1100 hPa

WARNING

FDM systems must NOT be operated in wet zones, wet rooms (swimming pools, saunas) or climatic chambers.

Direct contact with liquids must always be avoided, as the FDM-System is not protected against the entering of liquids. Liquids entering the device can cause fire, electrical shock or other severe accidents.

The FDM system is NOT specified for the operation in vacuum, hyperbaric or altitude chambers.

The FDM-System are not intended for operation in potentially explosive atmospheres of medically used rooms or oxygen-enriched atmospheres.

The devices must not be operated in proximity to e.g. engines or transformers with a high connected load as well as mains current lines, as electrical or magnetic interference fields can falsify correct measurements resp. turn them impossible.

2.2.2 Storage and Transport

Storage and transport of the FDM-System are only to be affected in the original packaging provided by zebris.

Temperature	-20°C to +70°C
Relative humidity	max. 95%, non-condensing
Protect from moisture	

For transport, it is recommended that the FDM system be lifted and carried by two people. The device can be safely lifted by the surrounding aluminum frame of the base plate.

When lifting and carrying, ensure that the FDM-System is held securely and moved in a controlled manner. Impact loads and dropping the FDM-System must be avoided. The FDM-System must be set down carefully to prevent damage to the device and injury to personnel.

2.2.3 User Obligations

- The relevant, general guidelines and/or national laws, national regulations and technical rules for the commissioning and the operation of medical products must be applied and fulfilled corresponding to the indicated purpose of the zebris product.
- Users are obliged to:
  - ✓ Observe all safety guidelines of the user manual.
  - ✓ Carry out any inspection and maintenance work on a regular basis as stipulated in the user manual.
  - ✓ Only use work equipment that is free of defects.
  - ✓ Check the functional safety and the proper condition of the device before operating.
  - ✓ Make all user manuals that are included in delivery and part of the FDM-System accessible to all users at all times and keep the manuals in close proximity of the FDM-System system.
  - ✓ Protect him-/herself, the patient or third parties against dangers.
  - ✓ Avoid a contamination through the product.
- When using the system, national legal regulations must be observed, in particular:
  - ✓ The valid industrial safety regulations.
  - ✓ The valid accident prevention.
- For the safety, reliability and performance of the components delivered by zebris, responsibility is assumed, if:
  - ✓ Assembly, extensions, re-settings, changes, or repairs were carried out through zebris, or third parties authorised by zebris, trained technicians or employees of authorised dealers. Storage and transport are only to be affected in the original packaging delivered by the manufacturer.
  - ✓ The device is operated in accordance with the user manual.
  - ✓ In case of repair, the regulations of the VDE 0751-1 “Recurrent test and test before commissioning of medical electrical equipment – general regulations” are fully complied with.
  - ✓ The components of information technology provided by the operator correspond to the technical requirements of hard and software included in this user manual and were installed and set up according to the relevant descriptions in this user manual.
  - ✓ The set-up room corresponds to the given environmental conditions of the FDM-System and the valid installation regulations.
  - ✓ The FDM system including comoponents is connected to the mains socket with a protective grounding conductor and is operated with the correct mains voltage.
  - ✓ Exclusively the software provided by zebris as well as the components and accessory parts listed in this user manual are used together with the system.

2.2.4 General safety instructions

- The application and operation of the system and the evaluation of the measuring data and their interpretation may only be carried out by trained qualified personnel. The manufacturer assumes no liability for any injury to persons, damage to property, or loss of data due to improper use of the software, the device or its component parts.
- The patients' data and measuring data may only be copied, moved, or deleted using the data-base function provided by the zebris application programs. In the case of data being changed intentionally without using the database functions, the user alone bears full responsibility for all risks involved.
- Measurement and analysis results should always be interpreted in the light of the clinical history of the patient and in the context of other diagnostic tests by a trained person proven and tested for their relevance.
- Should any measures for treatment be taken based on the measuring results, the measuring system may only be implemented as a supplementary means for evaluation by an expert. On no account can, or may invasively measures, or measures endangering the patient be carried out solely based on the measuring results without further verification of the measuring data by additional methods.
- Should there be any detectable damage to the device or component parts, they should be returned to the manufacturer for a safety check. It is not permissible to continue using the device or its component parts, as severe damage, and serious injuries - even lethal injuries - may result. The manufacturer or authorized sales partner must always be contacted in all cases of fault or doubt.
- If any fluids should penetrate the device, it is mandatory for the device to undergo a technical safety test. Damaged plug connectors and leads are to be replaced by an authorized service technician. The device must be put out of operation immediately, marked as "Not working“ and prevented from being used by removing the mains cable.
- The FDM-System must be checked at regular intervals to make sure it is functioning properly. More details on this can be found in the section, "Maintenance of the Device" in this User Manual
- Be sure that all the mains and connection cables are laid safely and that they are protected against stepping on, so that nobody can trip over them. Check all the cables and the connection plug regularly for any damage. Damaged power supplies and cables must be replaced before further operation.
- Never try to service the FDM-System in any other way as described in the provided user manual. When removing the covers, you may expose yourself to lethal voltages or other risks.
- We also point out that if any changes are made to this certified device or its components without the prior written consent of zebris, your legal right to operate the device will be nullified.
- At a maximum permitted ambient temperature of 40 °C, the temperature of the patient-contacting surface of the applied part may reach up to 48 °C. The contact time of the applied part with the patient must not exceed 10 minutes. Exceeding the permitted contact time may result in increased thermal stress on the skin.

3 Product description

3.1 System components

In its basic configuration the FDM-System consists of the following components:

- FDM platform
- External power supply unit
- USB cable (Type A-A, 3.5 m length)
- Application software zebris FDM
- Windows compatible computer or notebook
- User Manual for platform and software, equipment and zebris FDM Software

3.2 Technical specifications FDM-System:

Interfaces	USB Synchronization input/output Video synchronization Infrared synchronization
Connection	Interface box in bottom of housing frame
Measuring principle	capacitive force measurement
Operating voltage	16-18V DC
Power consumption	max. 60W
Power supply (external power supply unit)	100-240V AC / 50-60Hz
Measuring Range	1-120N/cm2
USB interface	5V DC / max. 500mA
Synchronization inputs/outputs:	5 V DC
Accuracy of the calibrated measuring range	(1-80N/cm^2) ±5% (FS)
Hysterese	≤ 3%
Mechanical crosstalk	-25dB
Pressure threshold	1N/cm²

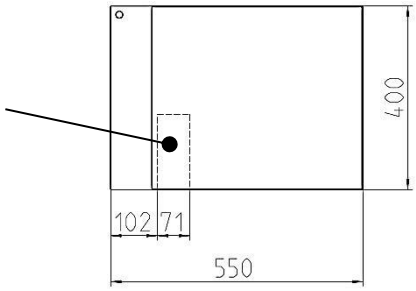
3.2.1 FDM-Sensor

The sensors of the different FDM system only vary in size of the measuring area, the number of single sensors included in the sensor module and the supported sampling frequency. All other technical data is identical

3.2.2 FDM platforms for stance and roll over analysis

Type	**FDM-SX**

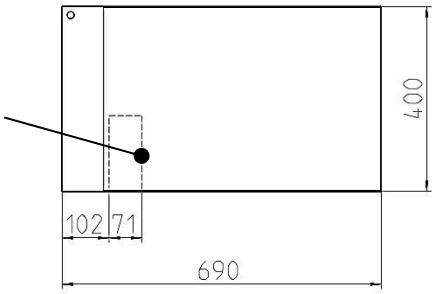
Connector box
(bottom side)



REF.-No.	01243005
Outer dimensions	550 x 400 x 21 mm (L x W x H)
Weight	ca. 4,8 kg
Measuring frequency	120 Hz
Number of sensors	40 x 48 / 1920
Sensor surface	400 x 330 mm (L x W)
Resolution	1/3“ resp. 1,4 sensors/ cm²
Infrared interface	optional

Type	**FDM-S**

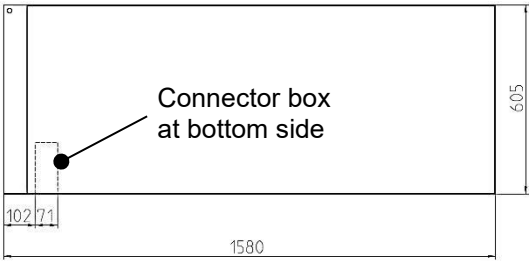
Connector box
at bottom side



REF.-No.	01243010
Outer dimensions	690 x 400 x 21 mm (L x W x H)
Weight	ca. 6,5 kg
Measuring frequency	120 Hz / optional 240 Hz
Number of sensors	40 x 64 / 2560
Sensor surface	540 x 330 mm (L x W)
Resolution	1/3“ resp. 1,4 sensors / cm²
Infrared interface	optional

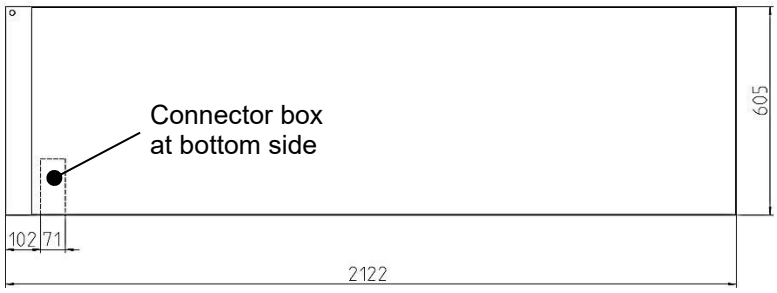
3.2.3 FDM system for stance and gait analysis

Type	FDM-1.5



REF.-No.	01243015
Outer dimensions	1580 x 605 x 21 mm (L x W x H)
Weight	ca. 16,5 kg
Measuring frequency	100 Hz / optional 200 Hz or 300 Hz
Number of sensors	64 x 176 / 11264
Sensor surface	1440 x 560 mm (L x W)
Resolution	1/3“ resp. 1,4 sensors / cm²
Infrared interface	integrated

Type	FDM-2



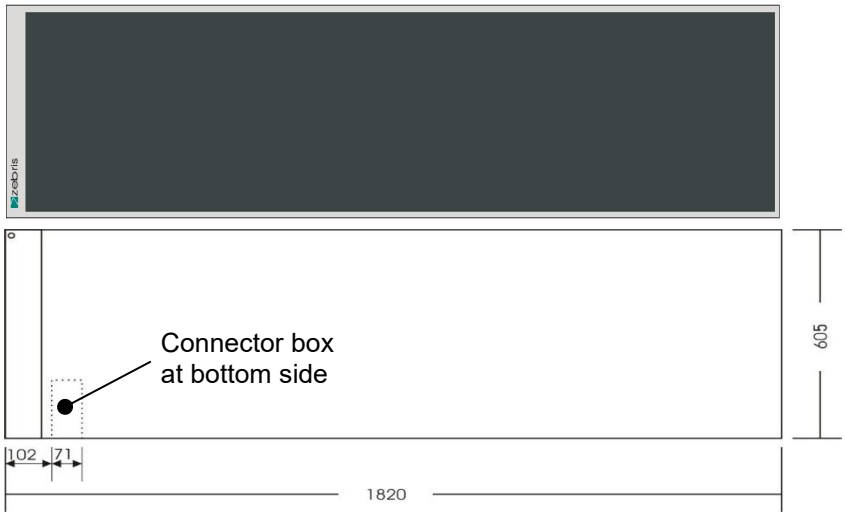
REF.-No.	01243020
Outer dimensions	2122 x 605 x 21 mm (L x W x H)
Weight	approx. 25 kg
Measuring frequency	100 Hz / optional 200 Hz
Number of sensors	64 x 240 / 15360
Sensor surface	2030 x 560 mm (L x W)
Resolution	1/3“ resp. 1,4 sensors / cm²
Infrared interface	integrated

Type	FDM-3

REF.-No.	01243030
Outer dimensions	3070 x 605 x 21 mm (L x W x H)
Weight	approx. 35 kg
Measuring frequency	100 Hz
Number of sensors	64 x 352 / 22528
Sensor surface	2980 x 560 mm (L x W)
Resolution	1/3“ resp. 1,4 sensors / cm²
Infrared interface	integrated

3.2.4 FDM platforms for gait training and rehabilitation applications

Type	**FDM-1.7**



REF.-No.	01243034
Outer dimensions	1820 x 605 x 21 mm (L x W x H)
Weight	approx. 22 kg
Measuring frequency	100 Hz
Number of sensors	44 x 136 / 5984
Sensor surface	1730 x 560 mm (L x W)
Resolution	1/2“ resp. 0.6 sensors / cm²
Infrared interface	optional

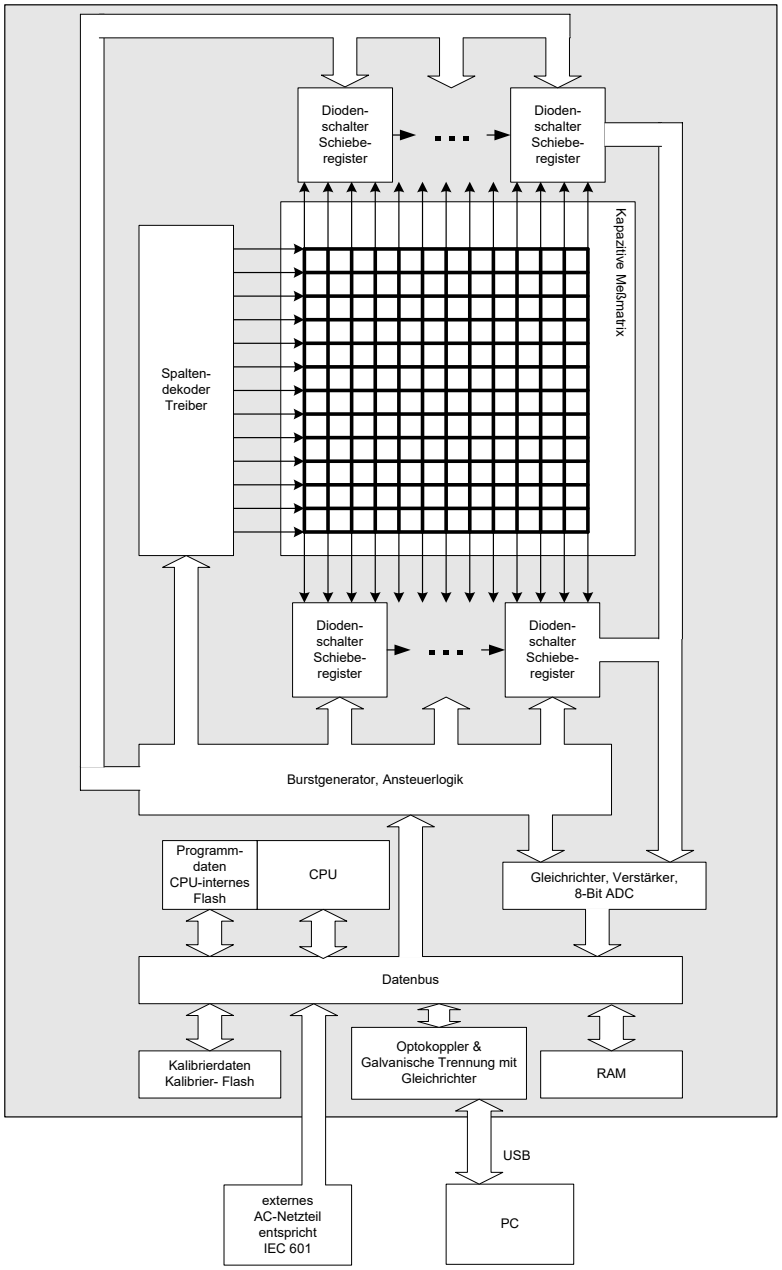
Type	**FDM-2.4**

REF.-No.	01243035
Outer dimensions	2510 x 605 x 21 mm (L x W x H)
Weight	approx. 31 kg
Measuring frequency	100 Hz
Number of sensors	44 x 190 / 8360
Sensor surface	2410 x 560 mm (L x W)
Resolution	1/2“ resp. 0.6 sensors / cm²
Infrared interface	optional

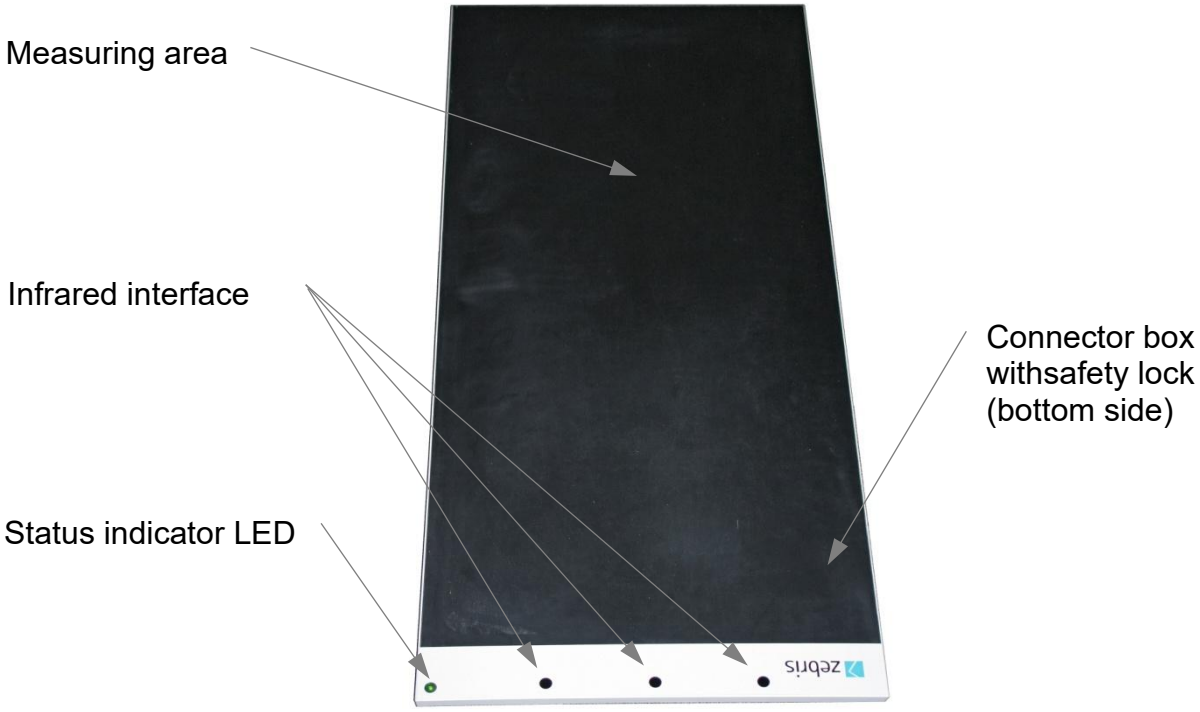
3.3 Measuring principle

The system contains a measuring matrix consisting of capacitive pressure sensors that are arranged in columns and lines running closely next to each other. For determining the force distribution over the measuring matrix, the capacity proportional to the force exerted is determined for each individual sensor. To do this, the drive logic generates several sinus burst signals equivalent to the number of columns via the column decoder and transmits them to the respective measuring column. The analog signal coupled into the shift register over the lines is proportional to the pressure-dependent capacity and is passed on for further processing to the control and signal-processing electronics and transmitted to the PC from there and shown on the display.

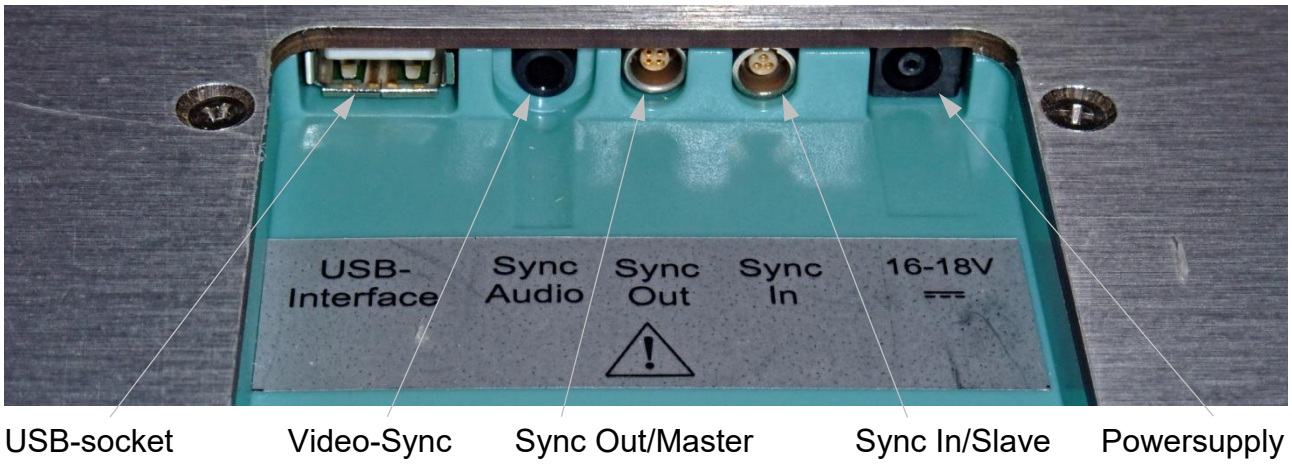
Schematic circuit diagram of the FDM-System



3.4 Controls and Connectors



All cable connections between platform and PC will be established by the connector box located at the bottom of the platform.



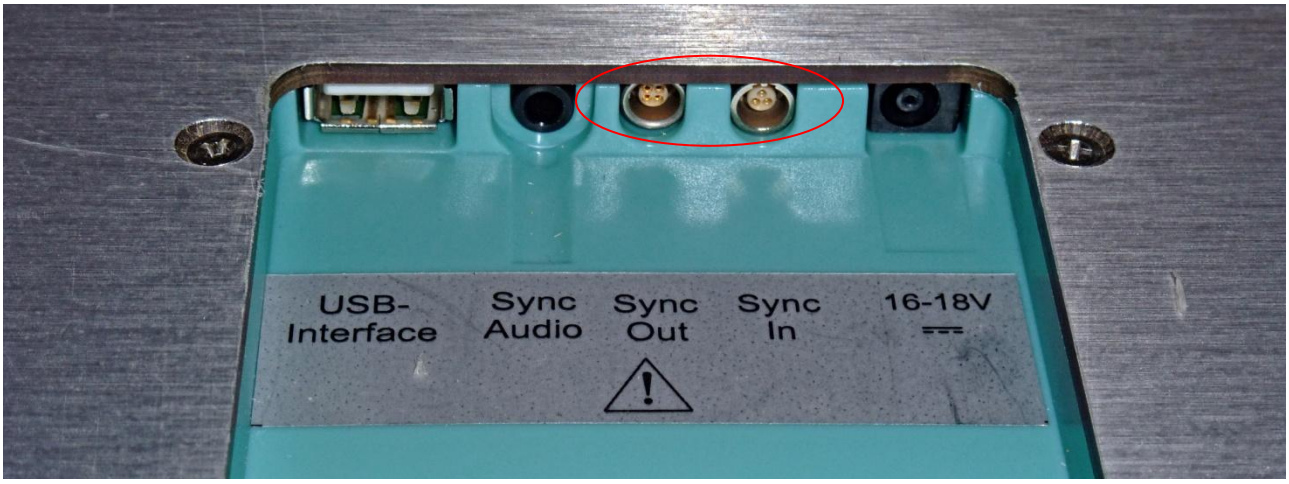
3.5 Status indicator LED

green flashing	the power supply unit is connected to mains, and a correct supply voltage is provided. A USB connection is not established yet or recognized. The platform is not ready for initialization or measurement.
green permanent	the power supply unit is connected to mains, and a correct supply voltage is provided. A USB connection is established and recognized. The platform is ready for initialization or measurement.
orange permanent	A measurement is in process.
orange / green flashing	A measurement is in process and infrared synchronization signals (from other zebris devices) are received. The orange flashing signalizes that valid synchronization signals are received.

3.6 zebris SYNC

The **zebris SYNC** is the standard solution for the synchronization of the FDM-System with measuring systems of third-party manufacturers as well as zebris camera and lighting systems.

The **SYNC-IN** and **SYNC-OUT** sockets provide inputs and outputs for support of „frame by frame“ In- and Out synchronization. Both sockets are galvanic protected from the platform.



WARNING

Patients’ safety is guaranteed by means of galvanic separation acc. to the provisions of IEC 60601-1 when a third-party device is synchronized with the FDM system. This allows non-medical equipment to be synchronized with the FDM system if such devices are out of patients reach (1.5m). Nevertheless, the user is completely responsible for the safety of all third-party devices used in combination with the FDM system.

The correct synchronisation of the measuring data of all coupled systems must be verified before evaluation as soon as a coupling with devices is carried out, that have not been manufactured by zebris.

zebris does not assume any warranty for the correct functioning and reliability of the system if the clock signals of external devices do not correspond to the indicated specifications.

3.6.1 Synchronization input (SYNC-IN)

If a third-party device is connected to the synchronization input SYNC-IN then depending on the setting of the configuration window from the application software the measurement will start/stop or “frame by frame” synchronized by a signal from the third-party device. Input is protected against faulty polarisation and pin 1 is set to +5V ("1") by an internal pull-up- resistor 2.7 kΩ. If this input is set to 0 V ("0") i.e., by a switch or break contact than the SYNC-IN is triggered.

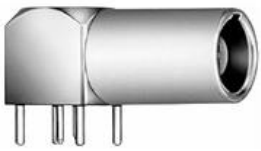
Electrical specifications

Input resistance (Pull-Up 5V)	2,7kΩ
V_{IH} (High-Level Input Voltage)	≥ 2,0V
V_{IL} (Low-Level Input Voltage)	≤ 0,8V
Required min. pulse time for triggering	1ms

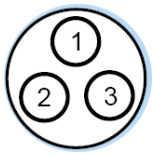
Built-in LEMO – Jack at Front of ZEBRIS Gauge

Series „00“, 3-pin, fitting Nut 30°

LEMO- Part. No. EPA.00.303.NLN



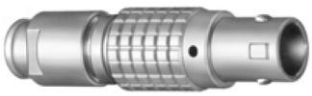
View
Front side



Fitting Nut: 30°

Suitable plug type for SYNC-IN:

LEMO- Part No. FGA.00 303.CLADxxxx



Pin assignment

Pin 1	Clk_IN
Pin 2	Activ_IN
Pin 3	GND

View
Solder side

Fitting Nut: 30°

3.6.2 Synchronization output (SYNC-OUT)

If a third-party device is connected to the synchronization output SYNC-OUT then depending on the setting of the configuration window from the application software will trigger a synchronized measurement of the third-party device either via start/stop or “frame by frame” mode.

Electrical specifications

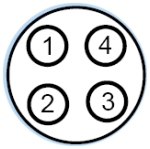
Output resistance	100Ω
High-Level	≥ 2,0V
Low-Level	≤ 0,8V

Suitable plug type for SYNC-IN

Series „00“, 4-pin, fitting Nut 0°

LEMO- Part. No. EPG.00.304.NLN

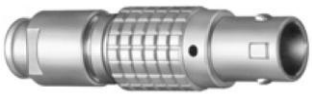
View
Front side



Fitting Nut: 0°

Suitable plug type for SYNC-OUT

LEMO- Part. No. FGG.00 304.CLADxxxx



View
Solder side

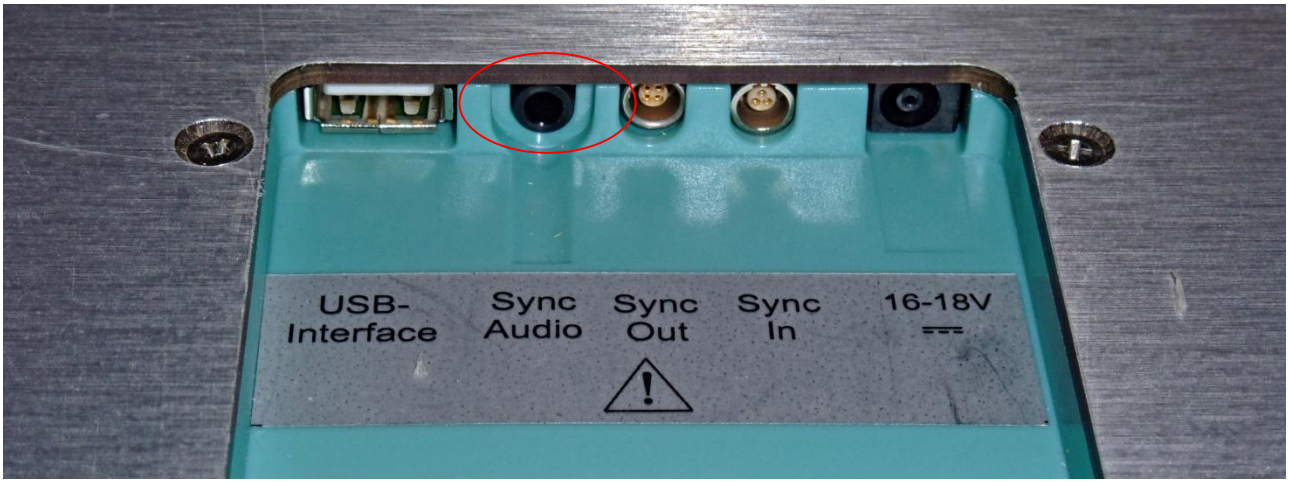
Fitting Nut: 0°

Pin assignment

Pin 1	+5V
Pin 2	GND
Pin 3	Activ_OUT
Pin 4	Clk_OUT

3.6.3 Synchronizing the FDM Platform with video data (Sync Audio)

The Sync-Audio socket serves for synchronizing platform measurement and video recordings of commercially available video cameras utilizing the external microphone input of the camera.



The synchronization is affected by imprinting a tact signal on the soundtrack of the video recording. This data is evaluated automatically by the application software WinFDM for synchronizing the platform data and the video signal.

For the connection to the video camera the following synchronization cable is required:

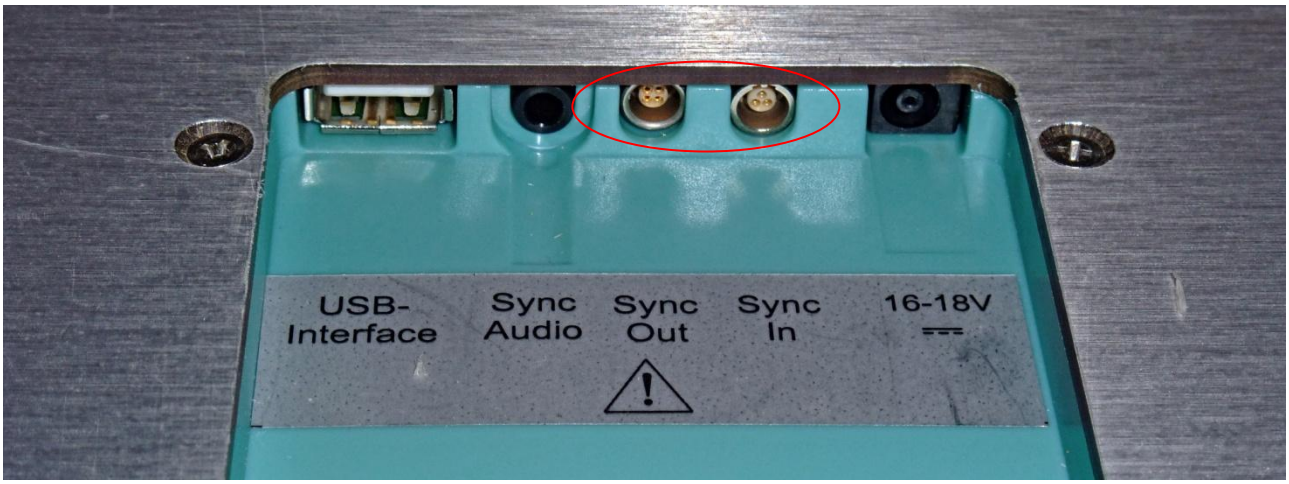
Item No. 21030310 / Video Sync-Control cable,
cable length 5m

3.6.4 Combine two FDM platforms of the same type

Two FDM platforms of the same type can be combined (Master – Slave) to double usable walking range. To accomplish this task a synchronization cable is required.

Item No. 01830019 / SC-PP Sync. Cable, length 10m

Both platforms must be connected to separate USB ports of the same PC. By means of the synchronization cable the “Sync Out“ socket of the master platform must be connected to the „Sync In“ socket of the slave platform. The WinFDM software then will recognize the platform combination automatically and show the corresponding sized measuring area.



NOTE

Be sure to position both platforms as shown below when connecting them for doubling the walking range.

NOTE

When using the zebris SYNCCam with two combinded plattforms it must be connected to the “Sync Audio” input of the master platform.

3.7 Replacement Parts FDM System

REF- No.	Description	Illustrations
33102230	**Power Supply MASCOT/3320** 60W/16VDC for FDM 1.5/1.7/2/2.4/3/ platforms comply with EN 60601-1 & UL	
33102234	**Power Supply MASCOT/3823** 15W/18VDC for FDM SX/S platforms complies with EN 60601-1 & UL	
07200011	**zebris FDM Software** for operating systems Windows 11 / 64 Bit	
79010105	**Hardware User Manual / English version** Please contact zebris support for free PDF version. Print version is liable to be charged.	
79010185	**User Manual** **zebris FDM software / English version** Please contact zebris support for free PDF version. Print version is liable to be charged.	
21030071	**USB 2.0 cable A -A** Data connection of FDM plate and PC Length 5 m	

3.8 Accessoires FDM-System

REF- No.	Description	Illustrations
01541000	**SYNCCam** Camera with USB-Cable, synchronization-cable, includes software extension	
01541220	**SYNCCam HS90** Camera with USB-Cable, synchronization-cable, removable aperture, synchronisation optionally via cable, includes software extension.	
21030321	**SYNCCam Hz USB-Cable A-B** USB-Cable for HD-video signal with high quality plugs, EMC-shielding, and ferrites length 5 m	
21030108	**SYNCCam HS90 USB-Kabel A-C** USB3.0-Kabel Länge 3m	
21030110	**USB3.0 fibre optical cable A-male/ A-female** Extension cable beteween USB3.0 cable A-C 5 m and PC, length 20 m	
21030316	**Video Sync-Control Cable 5** Length 5 m, both sides phone jack 3.5 mm	
21030312	**Video Sync-Control Extension Cable** Length 5 m, phone jack & socket 3.5 mm	

4 Video-Module

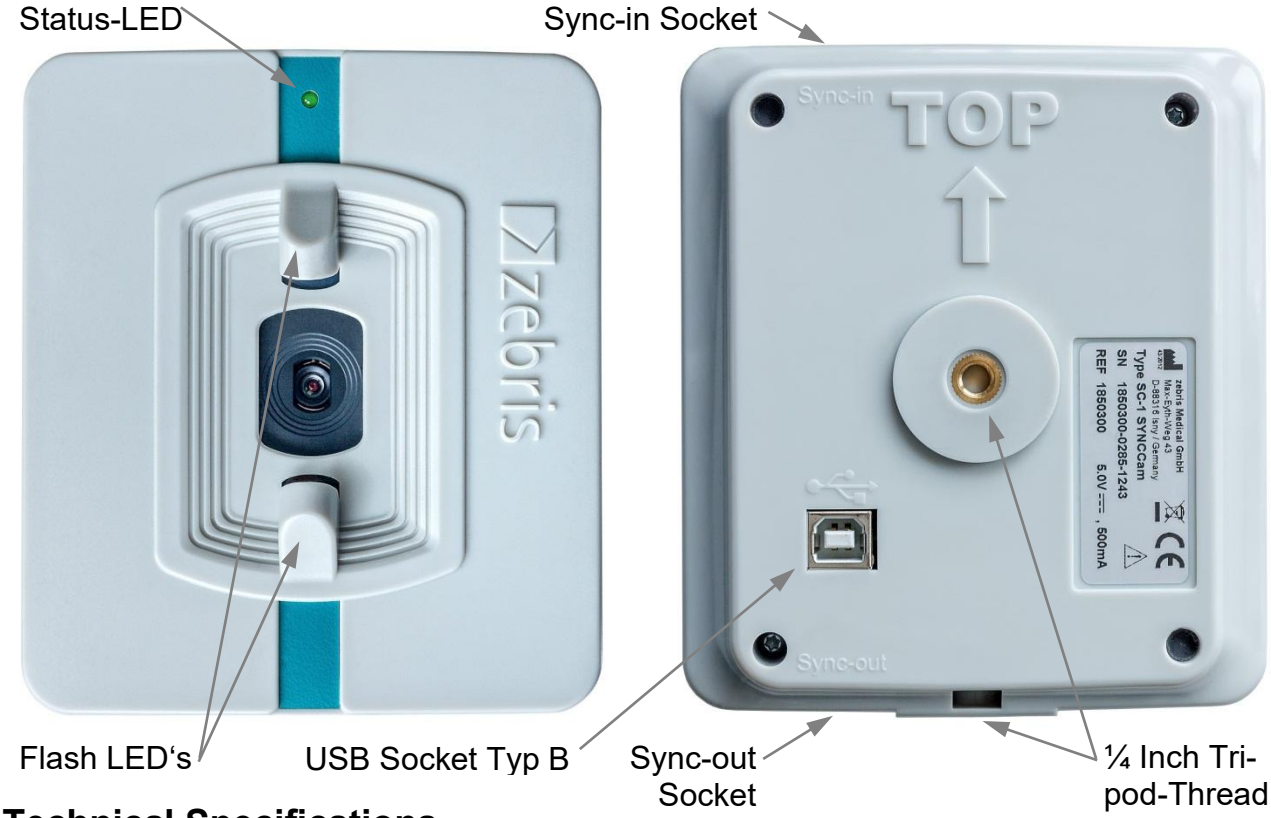
4.1 SYNCCam

The **SYNCCam** is an accessory of the FDM system and perfectly adapted to be used in combination with the force distribution measurement. All adjustments of the camera are carried out via hardware setup integrated to the zebris FDM Software. The camera is connected to the PC by a USB cable of type A-B included within the shipment.

The camera is equipped with ¼ inch tripod threads and can be adapted to zebris tripods as wells as commercially available camera tripods.

WARNING

The Sync-LEDs are flashing when the camera is disconnected from the USB port. Therefore, it is strongly advised not to look directly into the camera when it is disconnected to avoid dazzling.



Technical Specifications

REF	01541000
Dimensions	110 x 125 x 15mm (L x W x H)
Weight	approx. 190g
Power Supply	USB (5V DC / 500mA)
Resolution	1920 x 1080 Pixel (Full-HD) / Autofocus
Frame Rate	30Hz
Synchronization	LED-Flash triggered by Sync-IN socket
Mounting	¼ Inch tripod-thread at bottom and back side

NOTE

To maintain undisturbed transmission of the video signal it is mandatory to use high quality USB cables.

Please, only use cables supplied or recommended by zebris for connecting SYNCCam and PC.

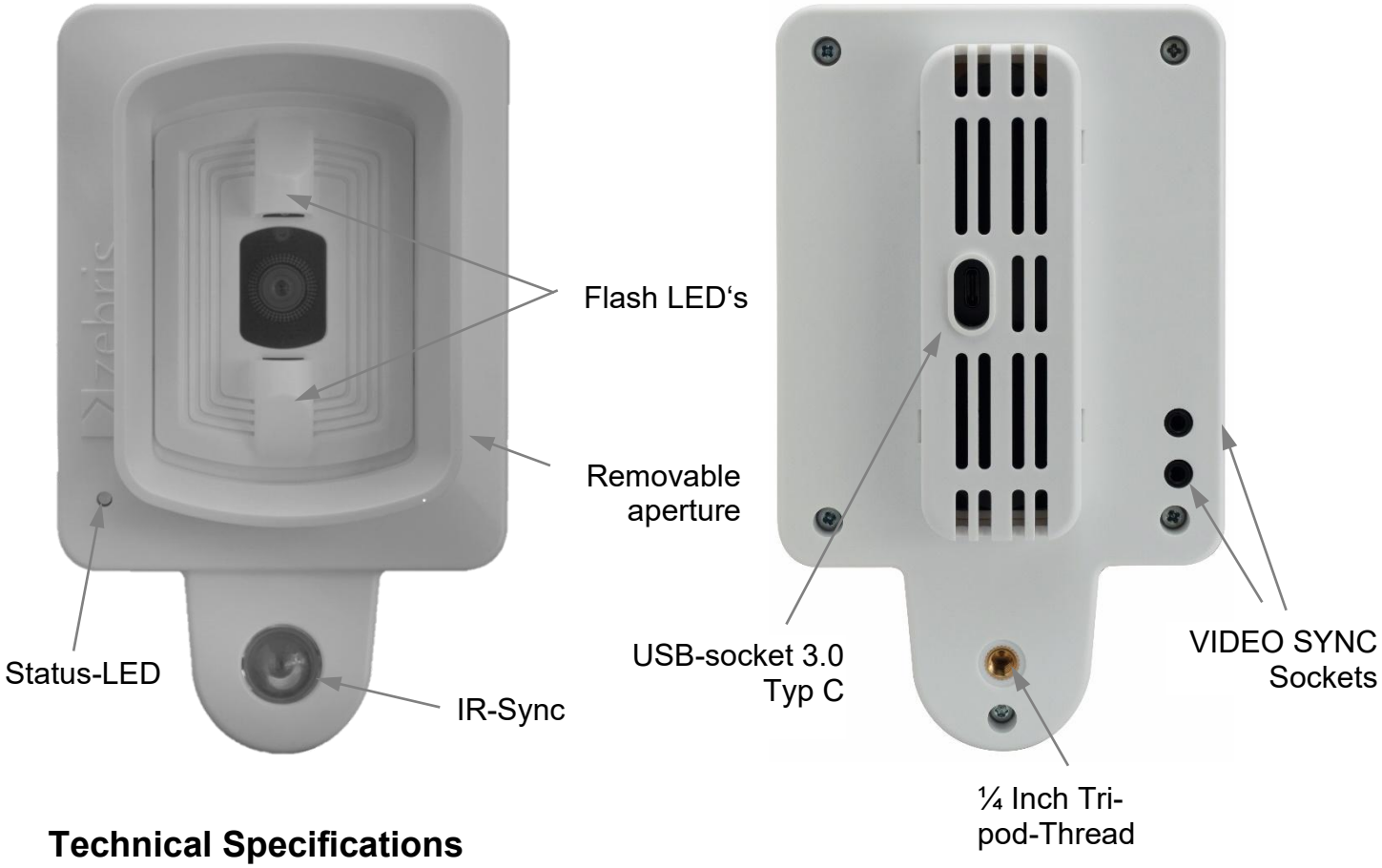
4.2 SYNCCam HS90

The **SYNCCam HS** is an accessory of the FDM system and perfectly adapted to be used in combination with the force distribution measurement. All adjustments of the camera are carried out via hardware setup integrated to the zebris FDM Software. The camera is connected to the PC by a USB cable of type A-C included within the shipment.

The camera is equipped with one ¼ inch tripod thread and can be adapted to zebris tripods as wells as commercially available camera tripods.

WARNING

The Sync-LEDs are flashing when the camera is disconnected from the USB port. Therefore, it is strongly advised not to look directly into the camera when it is disconnected to avoid dazzling.



Technical Specifications

REF	01541220
Dimensions	174 x 104 x 59mm (L x H x W) – with aperture 78mm width
Weight	approx. 275g
Power Supply	USB 3.0 (5V DC / 500mA)
Resolution	max. 1920 x 1080 Pixel (Full-HD) / Autofocus
Frame Rate	max. 90Hz
Synchronization	LED-Flash triggered by Sync-IN socket
Mounting	¼ Inch tripod-thread at back side

NOTE

To maintain undisturbed transmission of the video signal it is mandatory to use high quality USB cables.

Please, only use cables supplied or recommended by zebris for connecting SYNCCam and PC.

Resolution and Frame Rate

Resolution	Frame Rate
1920 x 1080 (Full HD)	60 Hz
1280 x 720 (HD)	90 Hz

Synchronization Options

VIDEO SYNC Wired synchronization with special synchronization cable included in the scope of delivery.

Infrared Synchronization via infrared signal without synchronization cable (not compatible with every zebris pressure plate). Cannot be used with the IR interface for zebris EMG.

Interpretation of the STATUS-LED

Green USB connected and infrared connection available.

Red Only USB connected, no active infrared connection available.

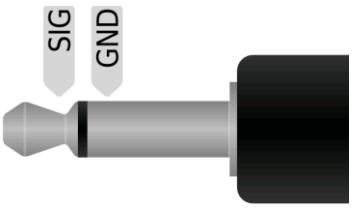
SYNC Socket

Characteristics

ESD - protected, voltage reversal proof input.

Input resistance: 38 kΩ (AC)
Signal-Level: AC
Trigger Level: 15 mV

Pin Assignment



5 Operation of the FDM System

5.1 Setting up the FDM-System

For the commissioning of the FDM platform the suitable power supply, a USB cable type A-A as well as the installation CD with the FDM application software are necessary. All components are included in the scope of delivery of the FDM-System.

- The underground of the set-up location must be plain and horizontal.
- The platform must be set up on a slip-proof underlay or installed in a catwalk, to exclude any danger to the test person caused by the platform sliding.
- Do not set up the platform near a source of heating or in direct sunlight in front of a window as a rise in temperature can lead to inaccurate measuring results.
- Set-up the FDM-System in a way, that the socket for the mains connection is always accessible easily and that the device can be separated from the power supply without obstacles.
- Once the FDM-System is set up safely and horizontally, it can be connected to the power supply and put into operation.

WARNING

Be sure that all the mains and connection cables of the FDM Platform are laid safely and that they are protected against stepping on, so that nobody can trip over them. Check all the cables and the connection plug regularly for any damage.

The cables therefore can be laid under a cable protection or fixed to the floor using a tape if necessary.

5.2 How to switch the platform on/off

The platform is switched on and off by software control as soon as the zebris FDM software on the PC is started. If the device has been connected correctly, the green LED operating indicator illuminates on the housing of the platform.

5.3 Connection of the FDM-System to mains supply

For the connection of the FDM platform with the mains, connect the power supply with the mains socket and the power socket in the connector compartment.

WARNING

Exclusively use the power supply unit approved by zebris for the operation of the FDM platform, which is suitable for the power supply of your platform.

Power Supply MASCOT/3823	REF	33102234
For the following platforms:	FDM-SX FDM-S	

Technical Data

Input Voltage:	90 - 264 VAC
Mains frequency:	47 - 63 Hz
Standby	≤ 0,075 W
Power consumption	max. 16 W

Pin arrangement / polarity

Power Supply MASCOT/3320 REF 33102230

For the following platforms: FDM-1.5, FDM-2, FDM-3
FDM-1.7, FDM2.4

Technical Data

Input Voltage:	90 - 264 VAC
Mains frequency:	47 - 63 Hz
Standby	≤ 0,075 W
Power consumption	max. 60 W

Pin arrangement / polarity

„**-**“Contact: Outer contact of the hollow plug

„**+**“Contact: Inner contact of the hollow plug

NOTE

Before connecting the FDM-System to the mains, compare the name plate indications of the power supply and the platform in terms of mains voltage and mains frequency with the local characteristics. Only connect when they are in accordance.

WARNING

Carry out a visual examination of power supply, mains connection voltage and socket as well as ground contacts before connecting resp. commissioning the FDM-System. Damaged power supplies, cables or connection sockets immediately must be replaced by a person authorised to do so.

5.4 Computer requirements

As a rule, the FDM-System is supplied together with a computer. If the system is to be operated using other computers or components, the user must then inquire whether the intended coupling guarantees the necessary safety for the test person, the operator, and the surroundings by consulting the manufacturer, the authorized zebris sales partner or by asking a specialist.

Please refer to the zebris FDM Software Manual for information on PC requirements.

WARNING

If the computer is not supplied with the FDM-System, the manufacturer shall not be held liable for any damage or malfunctions arising from a faulty coupling. Should additional hardware be built into the computer or software installed, the manufacturer shall not be liable for any malfunctions or damage occurring.

WARNING

Connecting the system to a network/data network can cause unforeseen risks for the patient or third persons. The zebris FDM data base is not intended for simultaneous use by several users. If the database of the zebris FDM software is to be installed in a network/data network, the operator is then obligated to determine, analyse, assess, and overcome any risks in this connection. Of particular importance are aspects concerning data protection, virus security, updates of the operating system and regular backups. The risk considerations must also include any changes made to the network/data network, e.g., update/upgrade of devices and components that are connected to the network.

Whenever possible, the connection of the PC system to the Internet should take place via a professionally maintained IT network in conjunction with a hardware firewall to minimize risks due to the Internet connection. Never access the Internet with administrator rights.

5.5 Installing the zebris FDM software

If your FDM-System is delivered without PC/laptop, please install the application software before connecting the FDM-System to the computer. Please find information on the installation in the user manual of the zebris FDM software.

NOTE

Please make absolutely sure that you have installed the zebris software before connecting the FDM platform to the computer using the USB cable.

If the platform is connected without installing the software before, problems when installing the device driver may occur and the system does not work.

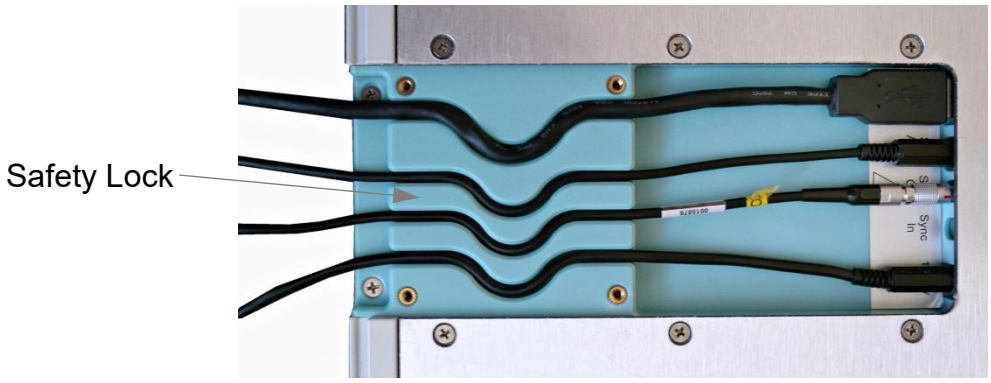
NOTE

How to solve problems with the hardware driver

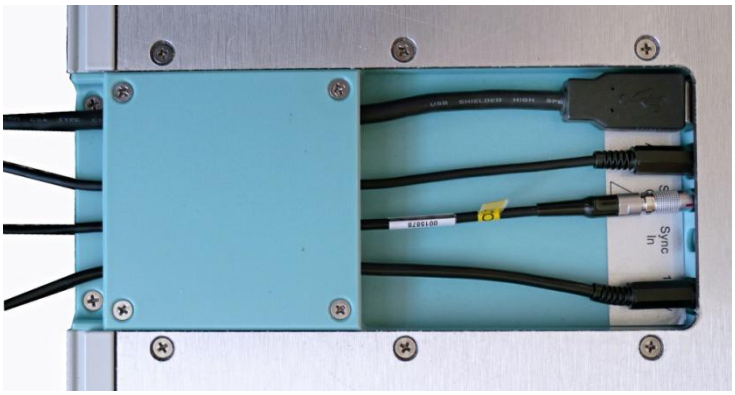
Should problems with the hardware driver of the FDM platform occur then disconnect the platform from the PC and restart it. Now proceed with installing the WinFDM software another time and reconnect the platform when the installation procedure has been finalized.

5.6 Closing the safety lock of the plug tray

Finally connect the USB socket in the connector compartment and a free USB interface of your computer by using the provided USB cable. Your FDM-System is now ready for use. The control of a measurement exclusively is carried out via the zebris FDM software. Therefore, please carefully read the zebris FDM user manual.



If the power supply unit and the USB cable are connected to the sockets of the platform, please close the lid of the safety lock, and fasten it to the housing by means of the four screws supplied with the platform.



5.7 Setting the system out of operation

To set the system out of operation please close the WinFDM software first, then exit the Windows operating system and shut down the PC. In the next step disconnect the power supply unit of the FDM sensor and the treadmill from mains supply.

5.8 Recommendations for recording data

To gain significant data from FDM platforms some principal guidelines should be followed. This chapter describes the ideal conditions for recording measurement data: The following points refer to the data reception of a person walking and describe the ideal measurement situation.

5.8.1 Walking range

The best conditions for measurements with platforms of the FDM-S type will be reached by integration of the system in a walking range. The complete walking range must be plane with the surrounding floor. This way the test person will not know the position of the platform and gives a workaround to the tendency that test persons try to walk exactly on the sensor area. The width of the stage should be about 1,20m. We recommend about 4m from start to FDM-S platform and no less than 3m behind. With such a walking stage it is easier to measure normal walking without acceleration or deceleration.
Of course, the same set up can be used to measure with the method of first step. The first step method is described as follow: The patient stands on one side of the platform in a distance to reach the platform by the first step. For measurement, the patient hits the sensor area by the first step and moves on. This kind of measurement guaranties reproducible steps and results. Notice: These results differ from these by normal walking.

5.8.2 Data recording

Please observe the exercise of the patient strictly. Only steps where the complete ground contact of the foot is located on the sensor area may be used for evaluation. If not, the complete foot area was measured by the system (foot did partially not hit the sensor area) the step can not be evaluated.

5.8.3 Gait velocity

For the measurement, a normal (individual) and constant walking velocity is necessary. Ideally an additionally measurement, e.g., by photo sensors, can proof the velocity for notice. Naturally, the patients adapt to the measurement situation within a few minutes. After a few trials, walking seems normal. A change in velocity of about 5 % is non-effective.

5.8.4 Posture

A visual control of the behaviour pattern of normal gait is recommended. Trials with atypical behaviour pattern should be deleted from interpretation. The patient must look straight ahead and must not be disturbed by paying attention to the platform or monitor. Marks on the wall in front of the patient can provide orientation to hit the platform.

5.8.5 Acrosclerosis

Different measurements (e.g., P.R. Cavanagh, *The Foot* (1994) **4**, 123-135) show an increase of plantar pressure peaks of about 30 % by acrosclerosis (e.g., weals). The interpretation of measurement data has to include the existence of plantar acrosclerosis.

6 Control measures, Preparation, Disposal

- Scheduled maintenance of the system is essential to prevent damage and guarantees the safety of the device. All methods concerning the system's maintenance and disinfection mentioned in this user manual should be carried out on a regular basis.
- Should any malfunctions and/or defects be determined or suspected, the device must be put out of operation immediately, marked as "Out of Service" and prevented from being used by removing the mains cable. In such case be sure to contact the manufacturer or an authorized sales partner.
- The maintenance of the device or its components, going beyond the procedures described in this user manual, must exclusively be carried out by zebris Medical GmbH or a person who has been explicitly authorized by zebris to do this.
- Be sure to switch of the FDM-System and disconnect it from mains supply before starting any maintenance work.

6.1 Mandatory periodic inspections

- For maintaining the correct state of the electrical equipment, checks and technical safety inspections must be carried out repeatedly (e.g., within Germany, acc. to BGV A3, and accident prevention regulations and technical safety tests according to the Medical Device Operating Regulations). Here it should be noted that standard regulations for electrical devices are concerned here and not measures that are specific to zebris.
- For safety reasons it is recommended before each use of the FDM-System, to check the correct state of all the connection leads, as well as the mains cable, mains plug and mains socket. Should certain parts be damaged, these must be replaced before continuing to use the measuring system.
- Immediate maintenance measures are to be carried out if:
  a) Fluid enters the device.
  b) Cable or cable connections have been damaged.
  c) Parts of the sensors were damaged.
  d) Covers have been damaged
  e) A malfunction or a fault is suspected or has been detected.
- If the name plate or other important labels (warning notices) are damaged or obliterated, they have to be replaced by the manufacturer for safety reasons.

6.2 Checking the FDM Platform

6.2.1 Control measures

WARNING

The correct measuring function of the FDM Platform must be checked at regular intervals to ensure that the measuring system is functioning properly.

Should any damage to the measuring surface become evident (e.g., something fell hard on the measuring surface), no further measurements must be taken. If visible damages are detected not further measurements are permitted.

After carrying out a baseline measurement, no measuring values may be shown for a condition without any load. In addition, the force distribution images are to be checked regularly for untypical measuring patterns. These include above all, line or column-shaped measuring patterns deviating from the surrounding values.

Whenever faults occur or in case of doubt, the manufacturer or sales partner authorized by zebris must always be contacted.

6.2.2 Calibration measures

The measuring accuracy of the sensors for the force distribution measurement is to be checked from time to time using a defined application of force.

To do this, the user, knowing the body weight, can stand on the platform on one foot. The platform must show the approximate body weight, taking the force of gravity, the sensors at the edges that may not be subject to the full pressure, and the measuring tolerance into consideration.

In case of deviations larger than > ±5% of max range a recalibration at manufacturers side is required.

I case of any doubts about the accuracy of the measurement it is highly recommended to send the platform to zebris premises for recalibration.

6.3 Troubleshooting

Please check the following points if technical malfunctions should occur:

- ✓ Is the FDM platform properly connected to the mains?
  (LED flashes green)
- ✓ Is the USB connection between platform and the measuring PC properly connected?
  (LED flashes green when the USB port and the power supply are connected to the PC and the device driver has been installed correctly.)
- ✓ Are all further components of the FDM-System (infrared synchronisation with zebris DAB-Bluetooth, video camera) properly connected?

NOTE

Please find further information on error messages and troubleshooting in the user manual of the zebris FDM software.

Checklist for the reception of error messages

NOTE

To support you the best way possible in case of malfunction of your FDM-System, our service employees need the following information:

- ✓ Device type + serial number of the FDM platform

  Serial number is located on the name plate on the left-hand side of the platform.
- ✓ Version of the zebris FDM software
- ✓ Version of the operating system of your measuring PC

  e.g., Windows 7 Professional Service Pac 1
  (Call under Windows 7: Windows Start button → Control Panel → System)
- ✓ Further components being connected to the FDM-System.

  e.g., Infrared synchronisation (IR) with zebris DAB-Bluetooth, video camera
- ✓ List of all USB devices that are connected to the measuring PC.

  e.g., mouse, printer, other measuring systems etc.
- ✓ Screenshot of the error message, or exact wording

  e.g., “EMG adapter not found.”
- ✓ Precise and detailed description of the procedure that led to the error message.

  e.g., Measurement “Type A” started, then clicked on button “B”, afterwards carried out movement “C”, switched to function “D”, when switching back, the error message xyz occurred etc.

6.4 Cleaning and disinfection

6.4.1 Cleaning

The platform and components are cleaned with a moist cloth while the device is switched off and the mains plug taken out.

NOTE

Do not use any aggressive agents to clean the FDM-System.

WARNING

Please be sure to switch off the device and pull the mains plug out of the socket before you commence disinfecting and cleaning

6.4.2 Manual Disinfection

The platform can be disinfected by wiping over with suitable agents. To clean, wipe the platform with a cloth soaked in disinfection liquid.

WARNING

No spray disinfection!

Spray disinfection can destroy the highly precise measurement sensors of the platform.

Recommended disinfection agent

Composition approx. 25% ethanol, 35% Propanol

E.g. Mikrozid Liquid / Schülke & Mayr or similar agents

NOTE

If you apply disinfection agent, be sure to follow the recommendations given by the manufacturer of the disinfection agent strictly. Especially consider the rules concerning the commended application time of the agent.

WARNING

Due to danger of confusion, chemicals that are necessary for the disinfection or cleansing exclusively must be stored, prepared, and provided in containers that are appropriate for this purpose.

NOTE

To demonstrate that disinfection was successfully done, it is recommended to put up a sign on the platform, saying “disinfected”.

6.5 Disposal

6.5.1 Packaging

All transport packaging delivered by zebris can be recycled within Germany via the local recycling depots. To provide the reuse of the recyclable material contained in the packaging, the zebris Medical GmbH takes part in the dual ZENTEK system that takes over the proper disposal of packaging.

6.5.2 Disposal of electronics

The symbol on the right (a crossed-out wheelie bin) indicates that, in accordance with EU Directive 2012/19/EU on waste electrical and electronic equipment (WEEE) and its national implementations (in Germany: ElektroG), this product must not be disposed of with household waste but must be separated from unsorted municipal waste.

Return to the manufacturer

At the end of its service life, zebris Medical GmbH, as the manufacturer, will take back the FDM-System free of charge as part of its product responsibility. The return must be arranged in advance with the following collection point:

zebris Medical GmbH Collection Point for Waste Electrical Equipment
Heinrich-Nicolaus-Str. 15, 87480 Weitnau
Contact: zebris Sales Team
Telephone: +49 7562 9726 0 | Email: sales@zebris.de

The end user is liable for the costs of delivery or postage to the collection point. The return of the device and its subsequent proper recycling by certified recycling companies are free of charge for the end user. No refund will be granted.

User responsibility for data erasure

Before returning the device, end users are personally responsible for erasing all personal data (in particular patient and measurement data) from the device. zebris Medical GmbH accepts no responsibility for data erasure on returned devices.

Background

The improper handling of end-of-life equipment can have negative effects on the environment and human health due to potentially hazardous substances frequently contained in electrical and electronic equipment. By disposing of this product properly, you are contributing to the effective use of natural resources.

7 Safety standards and system classification

The following information and warnings are listed according to the requirements of the standard DIN EN 60601-1, section 16 for medical, electrical systems and must be applied when operating the FDM system for medical purposes.

7.1 Classification acc. to Annex IX of Directive 93/42/EEC

If your FDM-System features a CE sign on the type label with a four-digit identification number of a notified body, the system is then classified as medical product **Class I with measuring function**.

7.2 Safety of medical electrical devices

The FDM platform fulfils the requirements of the standard DIN EN 60601-1.

Classification of the FDM Sensor according to DIN EN 60601-1

Type BF

Safety class II

Steady state conditions

Unsuitable for use in an oxygen-enriched atmosphere

7.2.1 Connecting the FDM-System to other electrical devices

(Additionally, refer to DIN EN 60601-1 Pos. 16 Medical Electrical Systems)

WARNING

The FDM system may only be connected to electrical devices that bear a CE marking. Devices with their own mains power supply must additionally comply with the requirements of IEC 62368-1 or DIN EN 60601-1. The input voltage of the connected device must not exceed 20 VDC.

WARNING

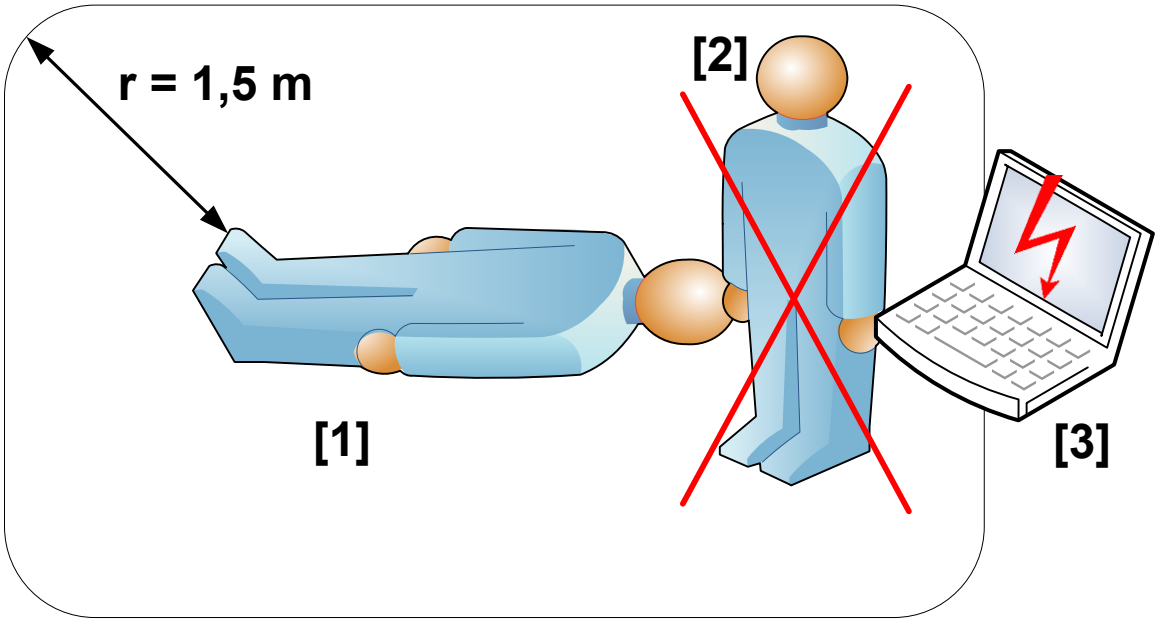
When coupling several devices to one measuring station, please note that no danger through summation of leakage currents can occur.

Devices that are in direct contact with the patient and that are commonly used in a medical electrical system, must fulfil all requirements of DIN EN 60601-1 section 16.

There is a danger of electric shock when touching devices that are not grounded separately.

7.2.2 Vicinity of the patient / test person

For the definition of the patient's surroundings, experience shows that a value of 1.5 m distance to the patient is optimal.



WARNING

When operating the system, the user [2] must ensure that he does not touch the PC [3] and the patient [1] at the same time. The same applies for all other non-medical, electrical components; they may only be used outside the patient's vicinity.

Furthermore, the user must ensure, never to touch the contacts of the connectors of the interface box and the patient at the same time.

In case of non-observance, dangerous leakage currents can occur.

WARNING

The computer and other non-medical electrical equipment (e.g., camera equipment, lights) must be located beyond the reach of the patients (1.5m).

7.2.3 Use of multiple sockets

The following information and warnings are based on the requirements of the Standard DIN EN 60601-1, Section 16 for medical electrical equipment and must be enforced when the FDM system is used for medical purposes.

WARNING

If multiple sockets are used for connecting the FDM platform or its components, the following safety regulations are to be observed:

- Always connect the FDM platform directly to mains supply by using a separate wall socket with a tested protective earth conductor and separate fuse.
- Multiple sockets can be used without causing any danger for connecting the PC and other electrical devices (video camera, illumination) outside the patients' vicinity.
- Multiple sockets must not be placed on the floor to avoid accidentally penetration of liquids or mechanical damages.
- It is forbidden to use extension cables, or several multiple sockets connected in series.
- In commercially available multiple sockets, system components set up within and outside the vicinity of the patient must never be plugged in together. (Example: It is forbidden to connect the PC and the power supply unit of the FDM platform to the same multiple sockets.)
- If multiple sockets are used jointly for components of the FDM platform, that are allowed to be located within the vicinity of the patient (e.g., FDM platform or other zebris FDM-System) and components that have to be outside the vicinity of the patient (e.g. PC, video camera), the multiple socket and complete interconnection of the system must adhere to all the requirements of DIN EN 60601-1 Section 16. If necessary, an isolating transformer is to be used for an arrangement of this kind, and the ground leakage current in the protective earth conductor of the multiple sockets must not exceed 5 mA. The adherence to the maximum permissible patient leakage currents is to be verified by measuring. If a multiple socket was integrated after setting the system into operation for the first time, no additional device may be connected to it (use multiple sockets with locking covers for this purpose)

WARNING

Coupling the mains connection of components of medical electrical systems and other, not supplied components by using multiple sockets according to EN 60601-1 is a very dangerous practice.

It is possible for excessive touch currents to occur if mains are connected without the user having any respective expert knowledge.

Due to these complications zebris Medical GmbH urgently advises not to use multiple sockets for operation of the system.

7.3 Electromagnetic compatibility Guideline & Manufacturer Declaration

The FDM-System is fully complies with all requirements of EN 60601-1-2.

Detailed information on EMC values and information supplied by the manufacturer can be found in the tables in this Section of the User Manual.

Electrical equipment in the medical field is subject to precautionary measures as regards the EMC (Electromagnetic Compatibility) and must be installed and put into operation in accordance with the instructions given below.

WARNING

Even though the FDM platform fully complies with the requirements of the standard EN 60601-1 it cannot be totally accepted that portable and mobile RF communications equipment can affect the system. If ever possible such devices should not be operated within the system environment during measurements

WARNING

The use of accessories, particularly cables for connecting to the PC, that are not supplied by zebris for use with the FDM platform, or explicitly recommended for use with the device, can lead to a reduced resistance to EMC interference of the FDM platform.

WARNING

The FDM-System should not be operated in the vicinity of e.g., X-ray equipment, motors, or transformers with a high connected load, as electrical or magnetic interference fields can influence the measurements. The same is applicable for neighbouring power lines and equipment without a CE mark. Should operation next to possible sources of interferences be necessary it is mandatory to check and verify the correct function of the system.

NOTE

In the case of over voltages or voltage dips (even short-term) of more than 50% of the mains voltage, functional faults can occur. When such high voltage dips or complete voltage failures occur, the measurement is interrupted, and the measuring data is discarded. Finally, the measurement has to be re-started, and if need be, also the connected PC including the zebris FDM software.

Guidelines and Manufacturer's Statement - Electromagnetic Emission		
The FDM-System is intended for use in the electromagnetic environment described below. The customer or user of the FDM force-distribution measuring system should ensure that it is operated in such an environment.		
Emitted interference measurements	**Compliance**	**Electromagnetic environment guidelines**
RF emissions acc. to CISPR 11	Group 1	The FDM-System uses RF energy exclusively for its internal functions. Therefore, its RF emission is very low and it is unlikely that electronic equipment in close proximity will experience interference.
RF emissions acc. to CISPR 11	class B	The FDM-System is intended for use in all facilities including those in residential areas and those directly connected to a public utility network also supplying buildings used for residential purposes.
Emission of harmonic oscillations acc. to IEC 61000-3-2	class B	
Emission of voltage fluctuations / flickers acc. to IEC61000-3-3	in compliance	

Guidelines and Manufacturer's Statement - Electromagnetic Interference Immunity			
The FDM-System is intended for use in the electromagnetic environment described below. The customer or user of the FDM-System should ensure that it is operated in such an environment.			
Interference immunity tests	**IEC 60601 test levels**	**Compliance level**	**Electromagnetic environment guidelines**
Electrostatic discharge (ESD) acc. to IEC 61000-4-2	± 6 kV contact discharge ± 8 kV atmospheric discharge	± 6 kV contact discharge ± 8 kV atmospheric discharge	Flooring should be of wood or concrete or laid with ceramic tiles. If the flooring is made of synthetic material, the relative humidity must be at least 30%.
Fast transient electrical interferences/bursts acc. to IEC 61000-4-4	± 2 kV for power lines ± 1 kV for input and output lines	± 2 kV for power lines ± 1 kV for input and output lines	The quality of the supply voltage should be the same as the voltage of a typical business or hospital environment.
Surges acc. to IEC 61000-4-5	± 1 kV differential mode voltage ± 2 kV common mode voltage	± 1 kV differential mode voltage ± 2 kV common mode voltage	The quality of the supply voltage should be the same as the voltage of a typical business or hospital environment.
Blackouts, brownouts, and fluctuations of the power supply acc. to IEC 61000-4-11	< 5% U_T (> 95% crash of the U_T) for ½ period 40% U_T (60% crash of the U_T) for 5 periods 70% U_T (30% crash of the U_T) for 25 periods < 5% U_T (> 95% crash of the U_T) for 5 s	< 5% U_T (> 95% crash of the U_T) for ½ period 40% U_T (60% crash of the U_T) for 5 periods 70% U_T (30% crash of the U_T) for 25 periods < 5% U_T (> 95% crash of the U_T) for 5 s	The quality of the supply voltage should be the same as the voltage of a typical business or hospital environment. If the user of the FDM-System requires the continuation of functionality also after power interruptions/disruptions, it is recommended to provide the FDM-System with power from an uninterruptible power supply.
Magnetic field with supply frequency (50/60 Hz) acc. to IEC 61000-4-8	3 A/m	Not tested as no influence is possible on the device within the specified test level. (see Note B)	Magnetic fields of the mains power frequency should comply with the typical values of a business and hospital environment.
NOTE U_T is the AC main voltage prior to applying the test levels.			

Guidelines and Manufacturer's Statement - Electromagnetic Interference Immunity

The FDM-System is intended for use in the electromagnetic environment described below. The customer or user of the FDM-System system should ensure that it is operated in such an environment.

Interference immunity tests	**IEC 60601 test levels**	**Compliance level**	**Electromagnetic environment guidelines**
			Portable and mobile wireless sets should not be used in closer proximity to the FDM-System, including the cables, than the recommended safety distance, that is calculated based on the formula suitable for the transmitting frequency. **Recommended safety distance:**
Conducted RF interference quantities acc. to IEC 61000-4-6	3 V_{eff} 150 kHz to 80 MHz	3 V_{eff}	$d = 1.2\sqrt{P}$
Radiated RF interference quantities acc. to IEC 61000-4-3	3 V/m 80 MHz to 2.5 GHz	3 V/m	$d = 1.2\sqrt{P}$ 80 MHz to 800 MHz
			$d = 2.3\sqrt{P}$ 800 MHz to 2.5 GHz
			With *P* as the rated output of the transmitter in watts (W) according to the information provided by the manufacturer of the transmitter and *d* as the recommended safety distance in meters (m). The field strength from fixed RF transmitters as determined by an electromagnetic site survey [a] is less than the compliance level [b] in all the frequencies. Interference is possible in the proximity of devices featuring the following pictograph

NOTE 1 The higher value applies in the case of 80 MHz and 800 MHz

NOTE 2 These guidelines may not be applicable in all situations. The spread of electromagnetic waves is influenced by absorption and the reflections of buildings, objects, and people

a The field strength of stationary transmitters, such as the base stations of mobile phones and land mobile services, ham radio stations, AM and FM radio and TV broadcasters are theoretically not 100% predictable. A site study is recommended to determine the electromagnetic environment because of stationary RF transmitters. If the measured field strength at the site of the FDM-System exceeds the compliance levels listed above, the FDM-System must be monitored to document its proper functionality at every place of application. Additional measures might become necessary, e.g., modifying the orientation or moving the location of the FDM-System, if unusual performance characteristics are observed.

b The field strength is less than 3 V/m for the frequency range of 150 kHz to 80 MHz

Recommended Safety Distances between Portable and Mobile RF Telecommunications Devices and the FDM-system

The FDM-System is intended for use in an electromagnetic environment where RF interference quantities are controlled. The customer or user of the FDM-System can contribute towards preventing electromagnetic emissions by complying with the minimum distance between portable and mobile RF telecommunications devices (transmitters) and FDM-System, as recommended below in accordance with the maximum output power of the communication device.

Rated output of the transmitter (W)	**Safety distance based on the transmitting frequency (m)**		
	150 kHz to 80 MHz $d = 1.2\sqrt{P}$	**80 MHz to 800 MHz** $d = 1.2\sqrt{P}$	**800 MHz to 2.5 GHz** $d = 2.3\sqrt{P}$
0.01	0.12	0.12	0.23
0.1	0.38	0.38	0.73
1	1.2	1.2	2.3
10	3.8	3.8	7.3
100	12	12	23

The safety distance for transmitters with a rated output not listed in the table above, can be calculated by applying the formula corresponding to the respective column, whereby P is the rated output of the transmitter in watts (W) as specified by the transmitter manufacturer.

NOTE 1 For calculating the recommended safety distance of transmitters in the frequency range of 80 MHz to 2.5 GHz, an additional factor of 10/3 was used to reduce the probability of a mobile/portable telecommunications device taken unintentionally into the patient's area, causing interference.

NOTE 2 These guidelines may not be applicable in all situations. The spread of electromagnetic waves is influenced by absorption and the reflections of buildings, objects, and people.