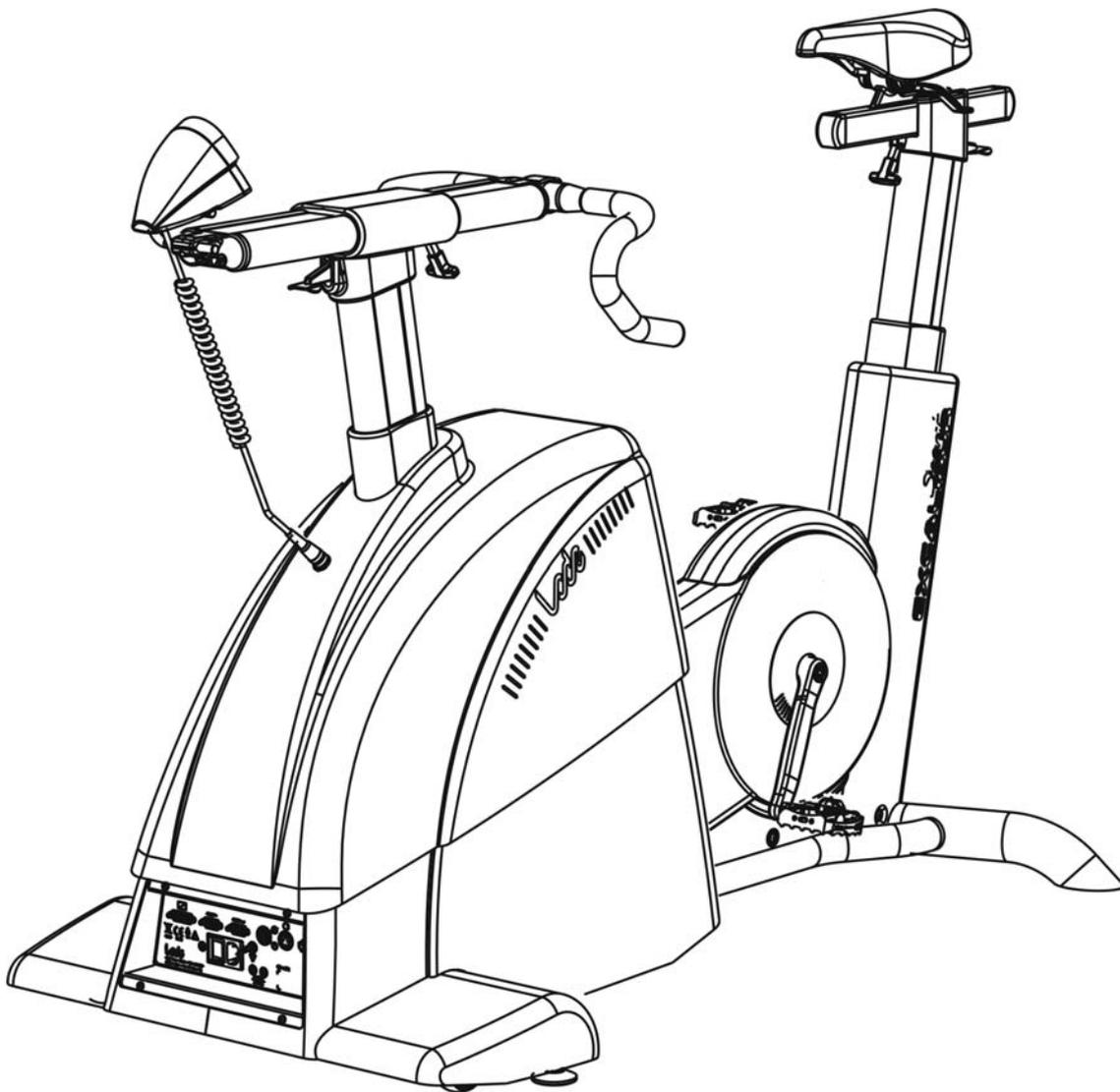


925900UE

User guide
Excalibur Sport
925900



Lode

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Groningen, the Netherlands

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0344

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- Excalibur Sport
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This is the user guide for the Lode Excalibur Sport Ergometer

Intended Use

A Lode ergometer is a diagnostic tool intended to be used as a stress test device in a medical environment. The main goal of the use of a Lode ergometer is to create reproducible stress tests. The following parameters can be measured:

Workload (watt)

Revolutions per minute (rpm)

Time (minutes and seconds)

Distance (km)

Optional: Blood Pressure (mmHg)

Optional: Heart rate (beats per minute)*

Optional: Energy (KiloJoules)

Optional: SpO₂

In combination with other diagnostic tools, like ECG or pulmonary function equipment, other important physiological data can be obtained, allowing a physician to evaluate a test subjects physical status.

A Lode ergometer is designed both for manual operation and for control by external ECG-, pulmonary equipment. In combination with optional software, the ergometer can also be controlled by a PC.

The ergometer has to be operated under the supervision of well-trained medical specialists, like cardiologists, pulmonologists and physiotherapists. The ultimate judgment whether a test subject should undertake a stress test with an ergometer and which protocols should be used must be made by the responsible medical specialist, based on the limitations of each individual, the medical history and all other applicable circumstances. Neither Lode BV nor its distributors assume any responsibility for the final use of its equipment.

**** Warning***

The signal of the Polar belt and receiver may be disturbed by external equipment. Therefore, it is recommended to check the surroundings and switch off or remove the source of the disturbance.

Contra Indication

The Excalibur Sport ergometer is to be operated by classified personnel only. As stated in the intended use, the Excalibur Sport is intended to be used in a medical environment. During the intended use the test subject will deliver energy. Application of the wrong dosis of energy could lead to permanent damage of the test subject health.

Maintenance

The Excalibur Sport should be calibrated once a year. In case any damage is observed of the Excalibur Sport Lode B.V. or his representative should be informed in order to execute the necessary repair(s). Service of the Excalibur Sport is restricted to factory-trained personnel only.

Precautions

Caution: This device should only be sold by, or on the order of authorized persons.

Caution: Not suitable for use in the presence of flammable anaesthetics.

Caution: Read all warnings posted on the exercise bicycle.

Caution: Read the owner's / user's manual and follow it carefully before using the ergometer.

Caution: Set up and operate the ergometer on a solid level surface.

Caution: Inspect the ergometer for worn or loose components prior to use. Tighten / replace any loose or worn components prior to using.

Caution: The physician should instruct the test subject prior to commencing an exercise program. If, at any time during exercise, the test subject feels faint, dizzy, or experience pain, stop and he or she should be consulted by the physician.

Caution: Do not wear loose or dangling clothing while using the ergometer.

Caution: Care should be taken in mounting or dismounting the ergometer.

Note

The voltage selector (115/230VAC) is inside the ergometer. The main unit panel has to be unscrewed. Voltage selection should be done by a technician!

Possible hazards

Using the Excalibur Sport according to intended use, contra indications, maintenance, precaution and common sense stated above may not eliminate all hazards. Possible residual hazards could be: wrong installation, wrong use, wrong dose, wrong interpretation of readings, mechanical breakdown of parts, software failure.

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1 Introduction

Congratulations on your new Excalibur Sport ergometer! This device will provide you optimal test possibilities. Your test subject will also enjoy using the Excalibur Sport (for its silent operating circumstances and its adjustability). The Excalibur Sport has standard possibilities for adjusting the workload of the ergometer. The basic Controller has one display to read out Workload, RPM, Heart rate (if option 928826 is available), Torque, Timer and Distance. The Controller can be upgraded with an automatic blood pressure module (option 928818). This enhances the possibilities for controlled ergometry.

The Excalibur Sport ergometer is especially designed to test professional athletes. The horizontal and vertical adjustability of the saddle and handlebar makes exact and optimal positioning possible. Besides the high performance aerobic tests, the Excalibur Sport can be used for the anaerobic Wingate sprint test with the optional software package. Standard toe-clips are supplied which can be easily changed for the commercial available clip systems.

Another feature of the Excalibur Sport is that it offers possibilities for communication with a range of other products (e.g. ECG devices, pulmonary function testing equipment).

1.1 Definition of terms

Hyperbolic Ergometry: The name hyperbolic ergometry refers to the curve between the pedaling speed (RPM) and the torque (T). This curve has the shape of a hyperbole (see Fig. 1 Hyperbolic ergometry). As a result from this hyperbolic relation the workload (W) is independent of the RPM in a special area (see Fig. 2).

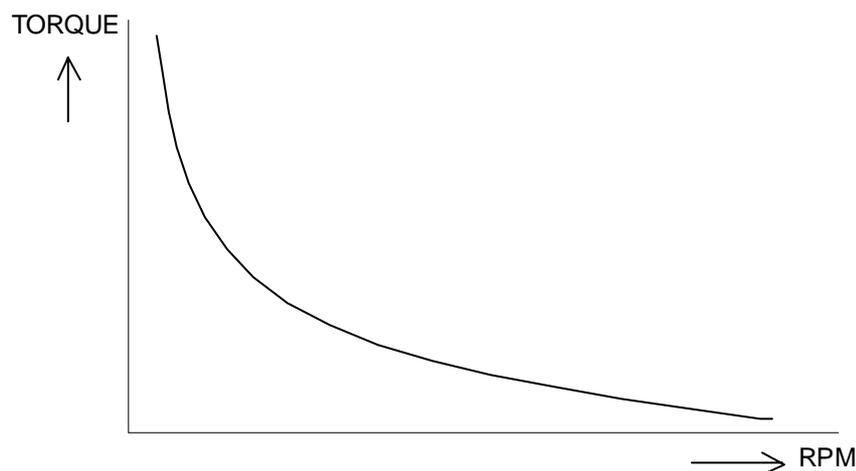


Fig 1: Hyperbolic ergometry

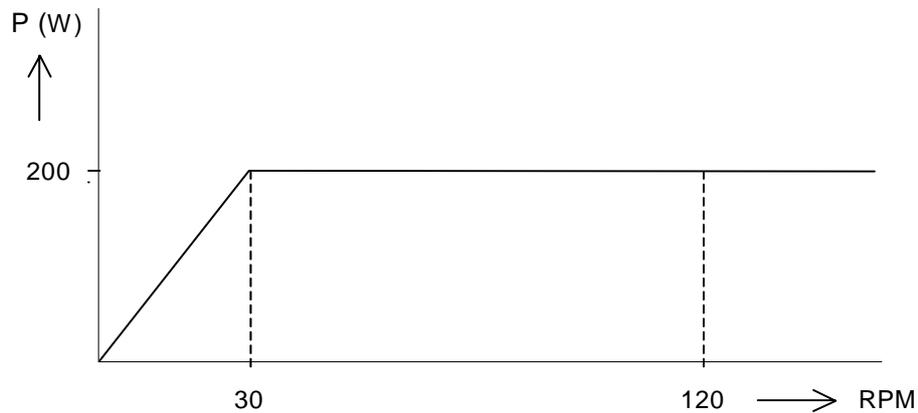


Fig 2: Hyperbolic ergometry: at a pedaling speed between 30 – 150 RPM the workload is constant 200 W.

Linear Ergometry: RPM dependent ergometry. The linear relation is determined by the relation between the torque (T) and the pedaling speed (RPM) (see Fig 3). As a result of this linear relation the workload (W) is RPM dependent (see Fig. 4 Linear ergometry). This means the faster the test subject is cycling, the higher the delivered workload. The linear braking principle is usually used in mechanical ergometers.

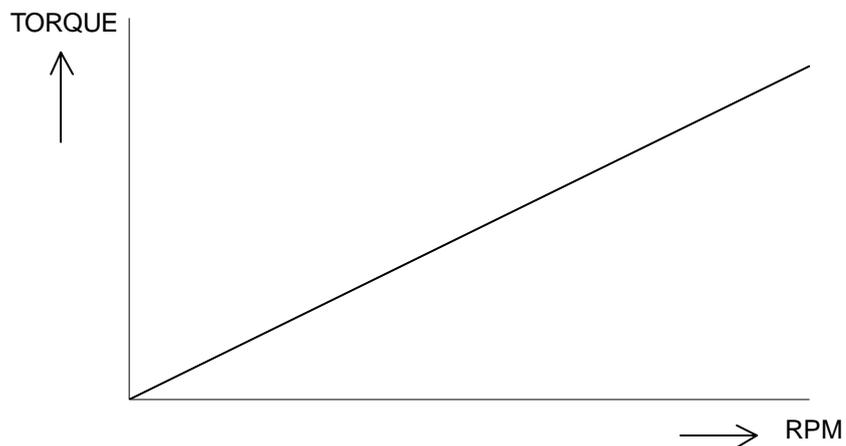


Fig 3: Linear ergometry

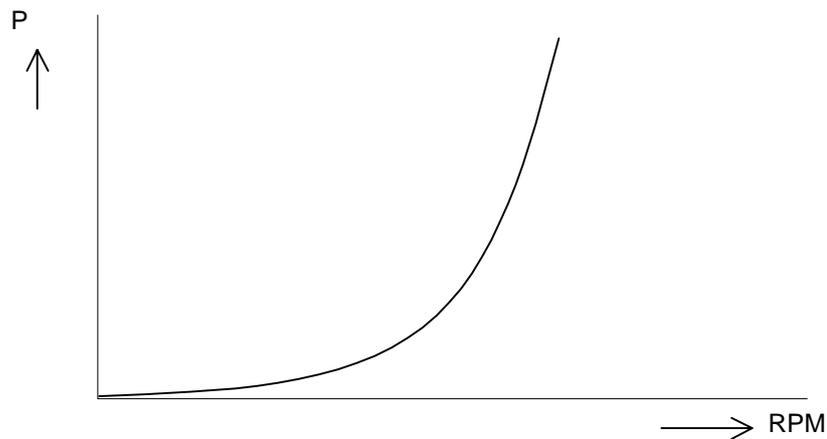


Fig 4: Linear ergometry (RPM dependent)

Linear Factor: the default value at the start of an exercise test. The formula that expresses the relation between RPM and Workload (P) is:

$$P = \alpha * \text{RPM}^5$$

Where α is a linear factor (= 0.044 in the Excalibur Sport). During programming a protocol the α is adjustable.

Fixed Torque Ergometry: In this case the torque is kept constant during exercise resulting in a linear relationship between the Workload (P) and RPM (n):

$$P = c * n \quad \text{with} \quad c = 2 * \pi * T$$

With the constant c defined as:

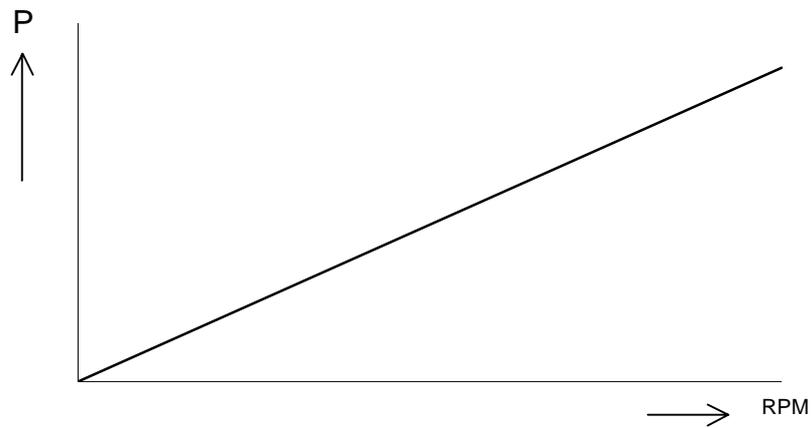
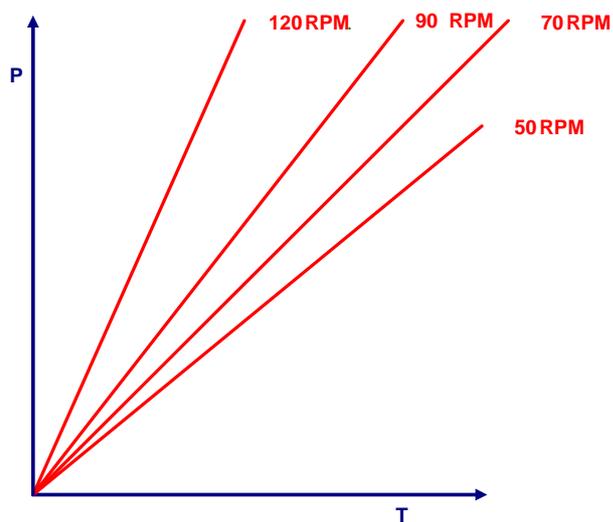


Fig 5: Fixed torque ergometry

Isokinetic ergometry: In this case the rpm is kept constant during exercise resulting in a linear relationship between the Workload (P) and Torque (Nm).

The rpm can be adjusted, this mode can be used to define the optimal rpm.



1.2 *List of symbols used*



On/Off switch



External Input



External Output



Type B Electrical Safety



 Separate collection of electric and electronic equipment

2 Description of the Excalibur Sport ergometer

The Excalibur Sport is a solid ergometer that can be used for high performance tests. The following will be described in this chapter:

- ! Identification of parts
- ! Control panel
- ! Main unit panel
- ! BP panel
- ! Adjustments

2.1 Identification of parts

The Excalibur Sport ergometer consists of the following main parts:

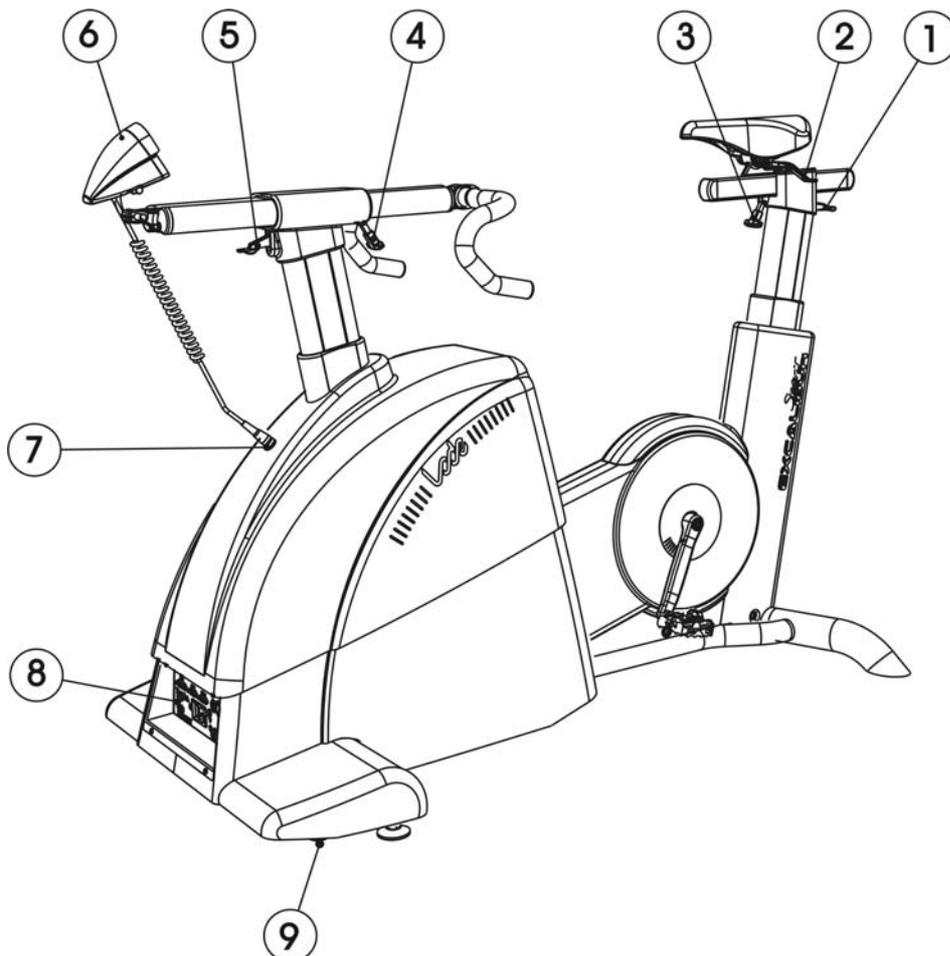


Fig 6: Excalibur Sport ergometer

1. Vertical Saddle adjustment
2. Saddle angle adjustment
3. Horizontal saddle adjustment
4. Handle for horizontal adjustment of the handlebar
5. Handle for adjusting the height of the handlebar
6. RPM set: display for RPM and Workload standard supplied with the Lode Excalibur Sport
7. RPM/workload connector: connector for the rpm set
8. Main unit panel: connectors and communication ports
9. Front wheels to move the ergometer when ergometer is lifted with horizontal saddle track

2.2 Control panel Excalibur Sport

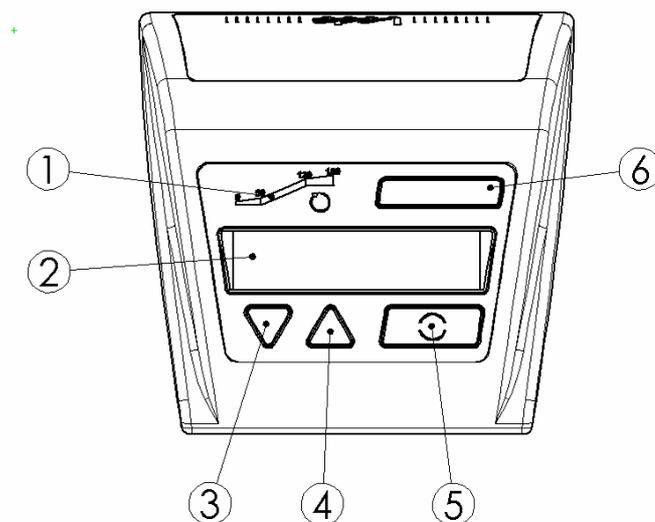


Fig 7: Control Panel basic Excalibur Sport

The control panel consists of the following elements:

1. LED indicator for RPM
2. Display A (2x16 characters) directed to test subject
3. down button
4. up button

5. confirmation button
6. ergometer type indication

2.3 Control panel Excalibur Sport with Programmable Display (option 928811)

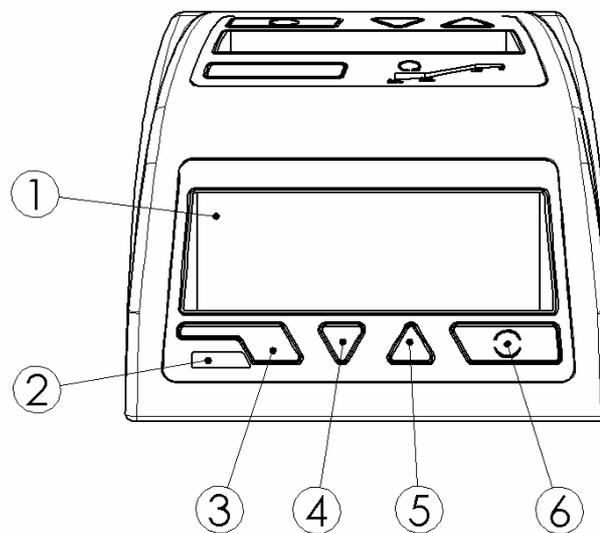


Fig 8: Control Panel Excalibur Sport with Programmable Display

The control panel at the front side is as described in 2.2. Besides that the other side of the programmable control panel consists of the following elements (Fig 8):

1. Display B (4x20 characters) directed to operator
2. Infrared window (only active for option 928820)
3. One-step-back button
4. Down button
5. Up button
6. Confirmation button

2.4 Main unit panel

The main unit panel of the Excalibur Sport contains the following elements:

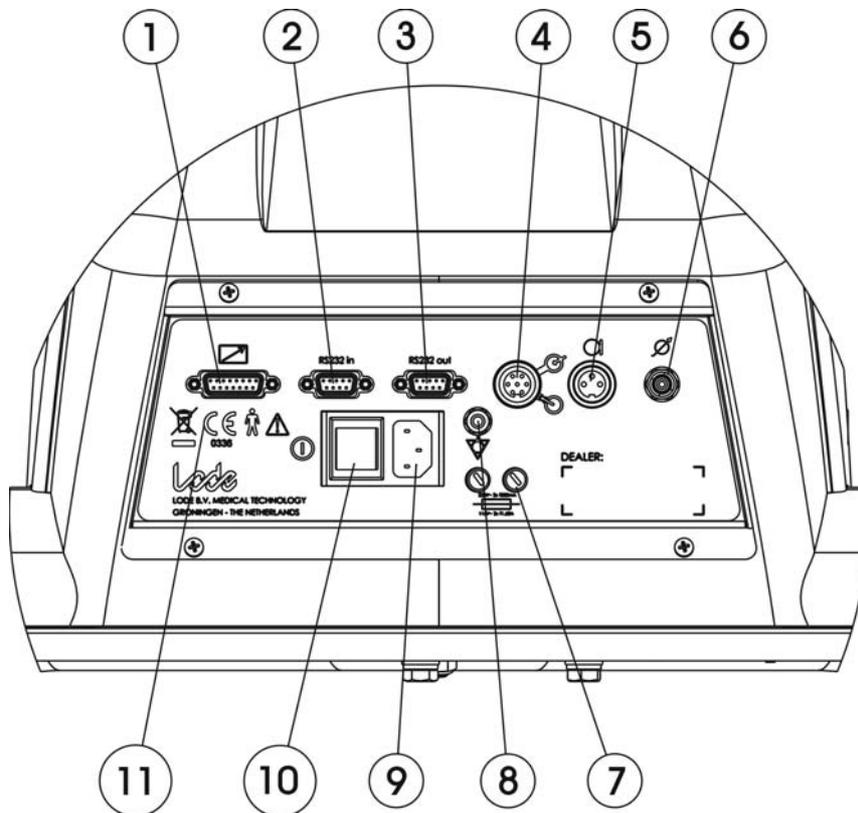


Fig. 9 Main unit panel connections

1. Control unit connector
2. RS232 input
3. RS232 output
4. Analog i/o
5. Microphone connector BP cuff
6. Airhose connector BP cuff
7. Fuses
8. Protective Earth connector
9. Mains connector
10. Mains switch

Note: The voltage selector (115/230VAC) is inside the ergometer. The main unit panel has to be unscrewed. Voltage selection should be done by a technician!

2.5 BP panel

To use the Blood pressure measurement option you need option 928818 (3.2). The cuff connections are shown in Fig. 9 Main unit panel connections.

2.6 Adjustments

The ergometer is adjustable to test subjects of all sizes and ages. See §2.1 figure 6 item 1 – 5. For the exact dimensions of the adjustability see figure 10.

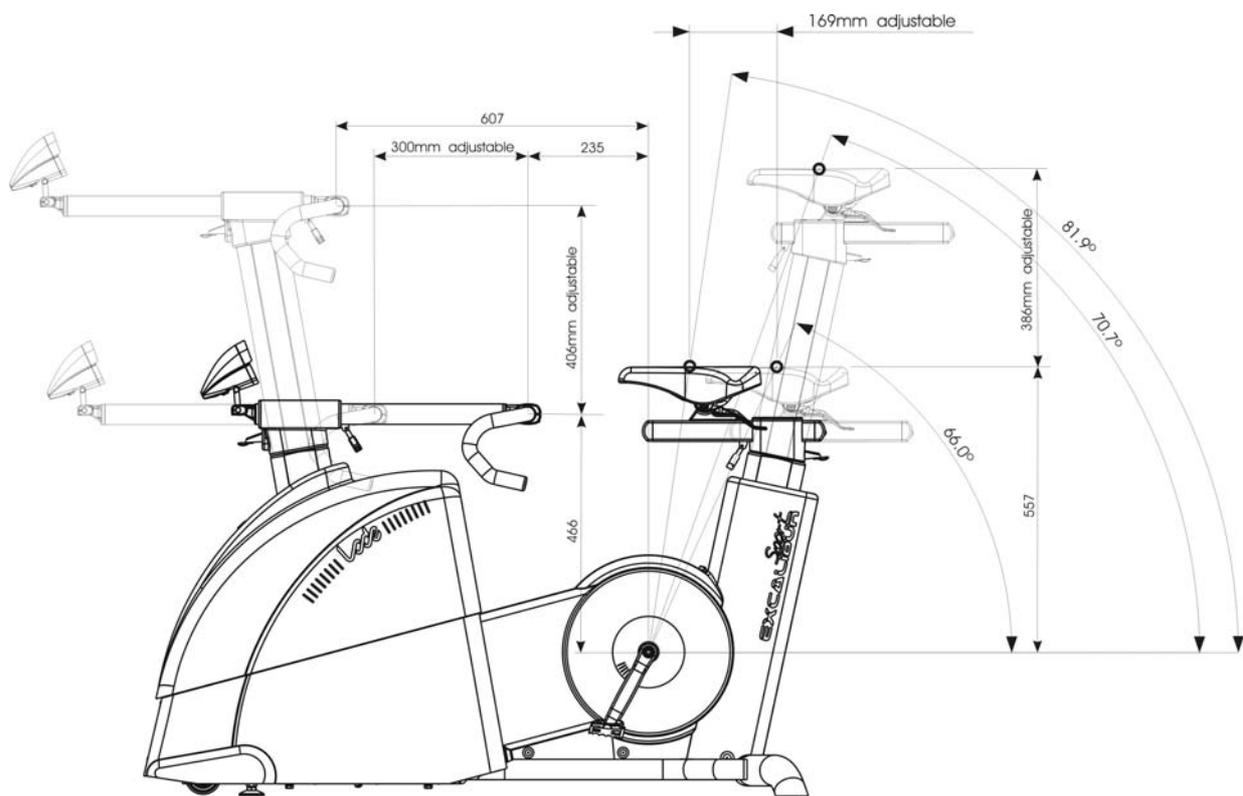


Fig. 10 Dimensions

2.7 Moving the ergometer

Moving the ergometer can be done by lifting the horizontal saddle track (fig 6). The two transport wheels on the front side of the ergometer can be used to ride the ergometer to its location.

3 Installing the Excalibur Sport ergometer

This chapter describes:

- ! What should be in the Excalibur Sport package
- ! Options.
- ! Instructions for installation.
- ! Connecting the BP cuff.
- ! Connecting the Heart rate system.

3.1 *What should be in the Excalibur Sport package*

Before installing the Excalibur Sport ergometer, check that the following items are included in the package:

- User guide part. no. 925900UE
- power cord part. no. 212010
- calibration rapport
- control unit
- cable control unit – Excalibur Sport

3.2 *Options*

Your purchase order should mention whether options have been installed in your ergometer. Contact your dealer if one or more of the above items is missing.

- ! **RPM set** part. no. 928201

The RPM set is an option. For the Imaging Tables with Excalibur Sport and the Excalibur Sport this option is standard supplied.

- ! **Programmable Display (P) Option** part. no. 928811

The programmable Display is an option with the Excalibur Sport. It should be installed by service personnel only. It offers program and protocol possibilities for workload (step, ramp), heart rate, torque and blood pressure (when option B 928818 is also ordered). Readout is done by a 4x20 characters LCD display with backlight. For operation four extra keys are available.

- ! **Programmable Display + SpO₂ + HR (SpO₂) Option** part. no. 928841

The SpO₂ is an option with the Excalibur Sport. It should be installed by service personnel only. It offers all features of the P Option. The SpO₂ module measures functional oxygen saturation of arterial hemoglobin (%SpO₂) and pulse rate (HR) for adult and pediatric patients. The Module can be used with several sensors: adult Articulated Finger Clip Sensor, Pediatric Finger Clip Sensor, Ear Clip Sensor, Reflectance Sensor, Adult Flex Sensor, Infant Flex Sensor or a Disposable Sensors Assortment Pack including 4 adult, 2 pediatric, 2 infant, and 2 neonate.

! 0 Watt Start-up System (0W) part. no. 925805

The 0 Watt Start-up System is an option with the Excalibur Sport. The 0 Watt Startup System gives the opportunity to start the ergometer without load (0 watt) at a preset pedal speed (rpm). You can choose any pedal speed between 30 and 80 rpm. The number of revolutions is increased from 0 to the required rpm by means of a motor drive. With this option there is no energy-loss due to the start-up phase. This option has to be built-in in the ergometer while manufacturing and cannot be added later on.

! Blood Pressure (B) Option part. no. 928818

The B Option is an option for the Excalibur Sport (not to be used during arm-ergometry). The B option allows you to measure the blood pressure of a test subject automatically before, during or after the exercise test. The B Option consists of a cuff with hoses and connectors for full blood pressure measurement possibilities.

Please note that installation of the BP option involves having to alter the wire systems inside the ergometer; the option should only be installed by service personnel in order not to make your warranty invalid.

! Heart rate (HR) option part. no. 928826

The heart rate option offers full monitoring facilities and can be readout via the display or over the RS232 port. You can create your own heart rate controlled protocols when you have ordered the P Option (928811) as well. The heart rate monitoring system consists of a Polar belt and a receiver. The receiver should be installed in the display unit of the ergometer or placed in front of the Test Subject.

For more available options see 7.4 Options. For installation and use of these options is referred to the Appendices.

4 Using the Excalibur Sport– quick start

This chapter describes how to use the standard Excalibur Sport.

- ! Internal control of the Excalibur Sport (Manual menu)
- ! Analog external control of the Excalibur Sport (Analog menu)
- ! Digital external control of the Excalibur Sport (Terminal menu)

When during an exercise test the rotational speed drops below 25 RPM, the braking force will be switched off. It will switch on again above 30 RPM (for more information see 6.1.1).

4.1 Manual menu (stand alone)

Execute the following steps for performing an exercise test with the Excalibur Sport after you have installed the ergometer as described in Chapter 3:

Switch on the Excalibur Sport with the mains switch on the back panel (Fig. 9 Back panel connections). The default start up menu of the control panel is the entrance to the MAIN MENU. Press the

() button to enter the main menu. Select with the arrow keys ▼ ▲ the MANUAL MODE.

<p>MAIN MENU</p> <p>MANUAL</p>
--

Press () and you will see the following screen (if not, see Chapter 5):

<p>P= 0W 0 rpm</p> <p> P MANUAL</p>

By pressing the ▼ ▲ keys, the workload can be in- or decreased. When pedalling starts the workload is applied above 30 RPM with an incremental speed of 25 watt/second. Keeping the () pressed for a few seconds allows you to go up one or more menu levels.

During cycling, the display shows the following information:

- ! The top line shows one or more ergometry parameters. For selection of the displayed parameters see Chapter 5. The RPM can also be readout at the LED bar graph above the LCD display.
- ! The bottom right corner shows the current exercise mode.
- ! At the bottom left position the selected adjustable parameter is shown. This is Workload P in this example but can be changed to other parameters as well (see Chapter 5).

4.2 Analog external control

Execute the following steps to control the Excalibur Sport externally using the analog in-/output:

1. Connect the external controlling device (e.g. ECG system) with a correct cable to the analog i/o port (see 2.4 Back panel). Be sure to use the correct cable for connecting the ergometer to an external (e.g. ECG) device. If you are not sure, please contact your supplier.
2. Restart the ergometer and select ANALOG in the main menu.
3. Now the ergometer can be controlled by an external device with an analog signal.

P=	0W	0 rpm
ANALOG		

The Excalibur Sport is now ready for external control.

For a technical description of the analog in-/output of the Excalibur Sport, see 8.4 Analog in/out of this user guide.

During cycling, the display of the control panel shows the same information as described in manual control.

4.3 Terminal – digital external control via RS232

For digital external control using the RS232 serial port execute the following steps for the basic Excalibur Sport:

1. Connect the Excalibur Sport to the external control device (i.e. ECG, PC) using a correct RS232 cable (see 2.4 Back panel and 3.2 Options for PC cables and Appendix E RS232 Connections for ECG specific available cables). If you are not sure whether your ECG device can be connected to the ergometer or not, please contact your dealer.
2. Switch on the ergometer and select the menu TERMINAL on the display of the control panel.

P=	0W	0 rpm
TERMINAL		

3. Be sure that the correct protocol has been selected under the menu SYSTEM PARAMETERS / SETTINGS / RS232 PROTOCOL (see 6.4.7 RS232 Protocol)

MAIN MENU
SYSTEM PARAMETER

SYSTEM PARAMETER SETTINGS

SETTINGS RS232 PROTOCOL

4. For a list of available protocols and ECG devices see App E. You can set the TERMINAL as a default start-up menu, when your ergometer is always controlled by an ECG device in the TERMINAL MODE, – see 6.4.1 Default
5. The Excalibur Sport is now ready for digital external control. If you intend to use blood pressure as well, take care of the following:
 - It is strongly advised to read Appendix D before starting with BP on your ergometer.

During cycling, the display of the control panel shows the same information as described in manual control (see 4.1). Another option to control the ergometer from a PC is with the Lode Ergometry Manager (LEM, article 92890x) software. This uses the Lode 38k4 protocol.

5 Main menu

When the ergometer is started after pressing the confirmation button () you will enter the MAIN MENU.

LODE ERGOMETER
TBD

The following submenus are selectable from the main menu:

- TERMINAL
- ANALOG
- MANUAL
- SYSTEM PARAMETER

Use the arrow keys ▼ ▲ to scroll through the menus. Press the () button to select a menu. Keeping the () pressed for a few seconds allows you to go up one or more menu levels, wherever you are in the menu. The complete menu structure is shown hereafter with its reference in this user guide. In front of each menu the level depth is indicated.

- 0. MAIN MENU (5)
 - 1. ANALOG (4.2)
 - 1. MANUAL (4.1)
 - 1. TERMINAL (4.3)
 - 1. SYSTEM PARAMETER (6)
 - 2. SET DISPLAY (6.1)
 - 3. POWER (6.1.1)
 - 3. RPM (6.1.2)
 - 3. HEARTRATE (6.1.3)
 - 3. TORQUE (6.1.4)
 - 3. TIMER (6.1.5)
 - 3. DISTANCE (6.1.6)
 - 2. SET P-SLOPE (6.2)
 - 2. SET MODE (6.3)
 - 3. HYPERBOLIC (6.3.1)
 - 3. HR CONTROLLED (6.3.2)
 - 3. LINEAR (6.3.3)
 - 3. FIXED TORQUE (6.3.4)
 - 3. ISOKINETIC (only available for Excalibur Sport 925900)
 - 2. SETTINGS (6.4)
 - 3. DEFAULT STARTMENU (6.4.1)
 - 3. KEYBOARD ON/OFF (6.4.2)
 - 3. TEST FUNCTIONS (6.4.3)
 - 3. P IN/OUT ANALOG (6.4.4)
 - 3. ECG TRIGGER (6.4.5)
 - 3. TC_BYTES (6.4.6)
 - 3. RS232 PROTOCOL (6.4.7)
 - 3. LANGUAGE (6.4.8)
 - 3. DEVICE NO (6.4.9)
 - 3. READ OUT SEATING POSITION (only available for Excalibur Sport 925900) (6.4.10)

6 System parameter

MAIN MENU
SYSTEM PARAMETER

In the System Parameters different ergometer specific settings can be carried out, from which the most important are:

- ! Selecting RS232 protocol.
- ! Adjusting the readout parameters.
- ! Trainings mode selection (hyperbolic, linear, fixed Torque, HR controlled).
- ! Selection of language, default start menu and I/O settings.

6.1 Set display

SYSTEM PARAMETER
SET DISPLAY

This function allows you to adjust the parameters which can be read out on the display during exercising that is in user guide, terminal or analog mode. Only two parameters can be displayed simultaneously. If more are set to ON they are shown in groups of 2 scrolling with a 5 second interval (see the example given in 6.1.3). The selection cannot be left keeping the () button pressed. You have to pass through all the possible readout parameters and afterwards you can choose to save the changes or not. When YES is chosen, this setting is kept even after new start-up. Choosing default allows you to go to default factory settings for the display parameters. These are P, RPM and heart rate set to ON.

SAVE
YES NO DEFAULT

Press the () button to go to the next parameter and switching the actual parameter ON/OFF is done with ▼▲ keys.

6.1.1 Power

POWER
On

Power indication in watt can be switched ON or OFF using the ▼▲ keys. The power displayed is the actual power of the brake. This means that regulation speed is incorporated. If, for instance, a workload of 400 W is desired and P-slope is 25 W/s it takes $400/25=16$

seconds before this workload is achieved. This holds also for workload reduction. Only when RPM drops below 25, the workload is removed at once, because the pedal torque becomes very high. Workload is put on the brake when RPM is more than, or equal to 30 RPM. Example of only workload readout in manual mode:

P= 100W	
P	MANUAL

6.1.2 RPM

RPM
On

Switch ON or OFF the cadence readout in revolutions per minute. The RPM can always be readout by the LED bar graph on top of the display independent of this adjustment. Example of RPM and workload readout in manual mode:

P= 100W	60 rpm
P	MANUAL

6.1.3 Heart rate

HEART RATE
Off

Switch ON or OFF the Heart rate indication in beats per minute. The ♥ symbol is used in the display. Be sure the heart rate is available either from the option 928826 or from an external source (i.e. ECG device via the analog I/O port).

Example of RPM, workload and heart rate readout in manual mode; you will now see the three subsequent screens below scrolling every 5 seconds to display the 3 parameters.

P= 100W	60 rpm
P	MANUAL

60 rpm	♥= 80/m
P	MANUAL

♥= 80/m	P= 100W
P	MANUAL

6.1.4 Torque

```
TORQUE
Off
```

Switch ON or OFF the torque in the readout. The torque is displayed in Newton meter. The torque (T) is coupled to Workload (P) and RPM (n) by the formula:

$$P [W] = (2 * \pi * n [min^{-1}] * T [Nm]) / 60$$

So when the workload is modified and P-slope (6.2) is at 25 W/s, the actual torque changes with the same speed (incorporating RPM for exact rate).

Example of RPM and torque readout in terminal mode:

```
60 rpm T= 8.9Nm
      TERMINAL
```

6.1.5 Timer

```
TIMER
Off
```

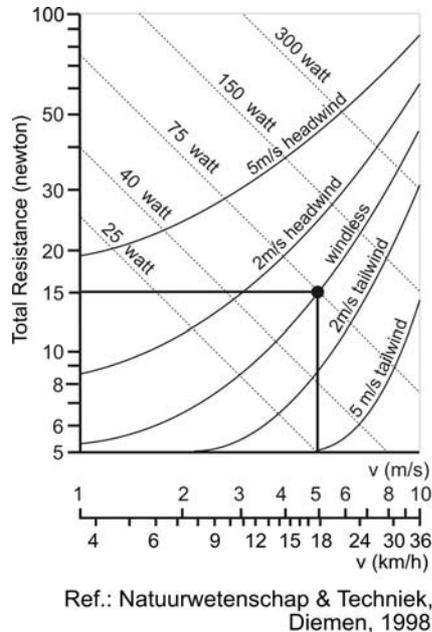
Switch the Timer ON or OFF in the readout. The timer is shown in the display as: Θ = **mm:ss**, indicating the time in minutes and seconds. The timer starts when you enter manual, terminal or analog mode and the RPM increases above 30. When the RPM drops below 30 during the exercise test the timer will stop until the RPM of 30 is reached again. The timer is reset when one of these modes is left. Example of workload and timer readout in manual mode:

```
P= 100W    $\Theta$ =01:34
      P      MANUAL
```

6.1.6 Distance

```
DISTANCE
On
```

Switch the distance ON or OFF. The distance is shown in the display as: → = **99,9 km**, expressing the distance in km.



To get an estimation of the distance cycled on an ergometer, this graph is used. Cycling costs energy and is dependent on the wind, air and rolling resistance. The total resistance is simulated and adjustable on the ergometer.

Without wind on a normal bike producing 75 watt (of exercise) (Force x velocity) and having a rolling resistance of 5N plus 10N air resistance, total 15N a cycle velocity of 5 m/s (18 km/h) can be reached (Free University Amsterdam, faculty of Human Movement science). When you have headwind force of 3Bft (= 5m/s) you will reach 9 km/h with the same amount of exercise (effort). With a tailwind force of 3Bft and 75 watt you can reach nearly 30 km/h. Top cyclists can easily cycle 300 watt. With your upperbody in the horizontal positioning you can half the air resistance. An aerodynamical recumbent roadbike will transform the exercise even more efficient in velocity.

6.2 Resistance

The total resistance can be adjusted in the control unit of the ergometer in [System parameters]. Go to [Resistance] and adjust the total resistance from 1-100 N. For different test subjects or applications a specific total resistance can be defined. In the [Set Display] the distance can be selected. The distance will be shown then on the display of the control unit during the test.

6.3 Set P-slope

The workload regulation steepness is set by this parameter to the default norm-value of 25 W/s,

SET P-SLOPE
25 W/s

or to maximal (Max), also directly after load adjustment.

SET P-SLOPE
Max. W/s

Be aware it will take a few seconds before a high workload modification is settled, when the P slope is set to 25 W/s. The regulation speed holds for both in- and decreasing workload. The

only exception is when RPM drops below 25. The workload is removed immediately in that case, otherwise pedalling becomes too hard. As soon as RPM rises above 30, workload is applied again with the desired regulation speed. The maximal value can be useful for sport and/or sprint tests.

6.4 Set mode

**SYSTEM PARAMETER
SET MODE**

Set mode is used to define which parameter can be adjusted during the exercise test in MANUAL mode with ▼▲ keys. With parameter one of the ergometry variables is meant, like workload, torque, heart rate and linear constant alpha.

6.4.1 Hyperbolic

**SET MODE
HYPERBOLIC**

Hyperbolic mode means that the workload P can be adjusted in watt. The workload is kept constant independent of RPM. When one of the ▼▲ keys is kept pressed in the hyperbolic mode, the workload is adjusted per W until the next decade, after that the workload is adjusted per 10 W until the next hundred and followed by steps per 100 W. This until the button is released.

Display during workload adjustment:

**P = 134 W
P MANUAL**

6.4.2 HR controlled

Heart rate can be adjusted and the workload is regulated until the target heart rate is reached. This means when the heart rate increases above the target level, workload is decreased and the other way around. The step size during adjustment is 1W. The units are beats per minute indicated as [/m]. Display during heart rate adjustment:

**♥ = 85/m
♥ MANUAL**

Workload regulation as a function of adjusted heart rate is done on a 30 second interval base, following the steps below (HR= actual heart rate in bpm, tHR= target heart rate in bpm, P = workload in [W]):

<i>If</i>	$HR > tHR + 15$	<i>then</i>	$P_{\text{new}} = P - P/8$
<i>Else if</i>	$HR > tHR$	<i>then</i>	$P_{\text{new}} = P - P/16$

Else if $HR > tHR - 5$ *then* $P_{\text{new}} = P$
Else if $HR < tHR - 5$ *then* $P_{\text{new}} = P + P/16$
Else if $HR < tHR - 15$ *then* $P_{\text{new}} = P + P/8$
Else if $HR = 0$ *then* $P_{\text{new}} = P$ (no HR available)

The initial workload is (P_{initial}) is 50 W.

6.4.3 Linear

In linear mode the workload P is coupled with RPM using the following formula:

$$P [W] = \alpha * (n [min^{-1}])^2$$

The linear coupling constant α is the adjustable parameter in this case. The default value for $\alpha = 0.042$ (giving for instance with 60 RPM a workload = $0.042 * (60)^2 = 151$ W). The unit of α is $[W/min^2]$ but it is shown dimensionless as a constant. Display during adjustment of α :

$\alpha = 0.046$
α MANUAL

6.4.4 Fixed torque

In the Fixed torque mode the workload is regulated in such way that the torque is kept at an adjusted fixed value, according the formula:

$$T [Nm] = (P * 60) / (2 * \pi * n [min^{-1}])$$

The torque T is adjusted in Nm:

T = 10.4 Nm
T MANUAL

6.4.5 Isokinetic (only available for Excalibur Sport 925900)

In the Isokinetic mode the rpm is regulated in such way that the rpm is kept at an adjusted fixed value, according the formula:

$$P [W] = (2 * \pi * n [min^{-1}] * T [Nm]) / 60$$

The rpm is adjusted :

rpm = 70
ω_c MANUAL

6.5 Settings

Under settings all device specific and interface adjustments can be made. It concerns all those items not related directly to ergometry.

**SYSTEM PARAMETER
SETTINGS**

6.5.1 Default Start menu

Normally your ergometer starts in the main menu, but you can modify this menu to your own desired settings. This is convenient when your ergometer is often used in the same setting, i.e. controlled by an ECG device or always as a stand alone set up.

**SETTINGS
DEFAULTSTARTMENU**

The following menus can be selected as start menu:

MAIN MENU
MANUAL
TERMINAL
ANALOG

At the next start-up of your ergometer the selected menu will be activated.

6.5.2 Keyboard On/Off

If you do not want to interrupt an exercise test or you do not want the test subject to interrupt the exercise test by pressing a key accidentally, the possibility is offered to disable the keyboard.

**SETTINGS
KEYBOARD ON/OFF**

The default setting is ON. If the keyboard setting is modified and saved, it will first be activated after new start-up.

**KEYBOARD ON/OFF
Off**

This is a convenient function to use together with TERMINAL as default start menu when you use the ECG system as the controlling device and do not want a test subject to interrupt the exercise test.

To get back the control of the keyboard act as follows:

! Switch off the ergometer

- ! Switch on again while keeping the () button pressed. The control by the keyboard is returned when you select ON in SYSTEM PARAMETERS / KEYBOARD ON/OFF.
- ! At the next start-up of the ergometer the keyboard is enabled again.

6.5.3 Test Functions

For service and calibration of the device, a number of diagnostic tools are available in the software. They are hidden under Test functions.

```

SETTINGS
TESTFUNCTIONS

```

You need a safety code to enter the TESTFUNCTIONS. They are not accessible for end users. Contact your supplier in case service of the device is required. **If, accidentally, you get into to the TEST FUNCTIONS it can cause damage to the ergometer operation and guarantee will be lost!**

```

TESTFUNCTIONS
Security code

```

6.5.4 P In/Out Analog

The ergometer can be controlled by an external device which has an analog output only (i.e. some older ECG devices). This can be done with the ANALOG mode.

```

SETTINGS
P IN/OUT ANALOG

```

With P In/out Analog the analog scaling can be adjusted. The following scales are available:

- ! 1 V analog in corresponds with 100 W workload
- ! 1 V analog in corresponds with 200 W workload
- ! 1 V analog in corresponds with 500 W workload

Example of most used scaling:

```

P IN/OUT ANALOG
1 V = 100 W

```

For the best accuracy it is advised to use this scaling. This restricts the P_{in} to 500 W and P_{out} to 1000 W. Only if you need higher workloads, increase to 200 or 500 watt/volt. If you are unsure, contact your supplier.

6.5.5 TC Bytes

The Test code (TC) Bytes offers, in case of malfunction or poor performance of the BP option (App. D), the possibility to make error codes visible. The interpretation of the error codes should be done only by experts. Ask your supplier for more information.

SETTINGS
TC BYTES

Setting the TC bytes to ON gives you an extra display possibility to scroll through after the blood pressure measurement. Restart of the ergometer sets TC bytes automatically OFF.

6.5.6 RS232 Protocol

When the ergometer is externally controlled via RS232 a protocol should be select here.

SETTINGS
RS232 PROTOCOL

The following protocols are currently available:

1. LODE protocol
2. LODE prot 38k4
3. BOSCH EKG 506
4. LODE WLP
5. ERGOLINE P10
6. ERGOLINE P4
7. SCHILLER

Check in Appendix E which protocol and cables should be used with your device. When your device is not listed please contact your supplier!

6.5.7 Language

You can choose different languages for the ergometer.

SETTINGS
LANGUAGE

Currently English, German, French, Spanish and Dutch are available. The default setting is English.

6.5.8 Device No

When RS232 communication is used with the ergometer, it is identified with a so called device number. This offers the possibility of looping through ergometers. Each ergometer should have its unique device no in that case. The ergometer respond only to RS232 commands proceeded with their unique device number or with zero. The response of the ergometer is also preceded with its device no.

SETTINGS DEVICE No

This might lead to problems when the ECG device expects any specific number (i.e. device no=1) in return. When this is the case, modify the device no to 1 to solve the problem. The default setting is 0.

DEVICE No ↓ ↑ No = 1
--

6.5.9 Read-out seating position

With this setting on the Excalibur Sport the most important parameters of the seating position are shown on the display. Adjusting the seat or handlebar will immediately be visible.

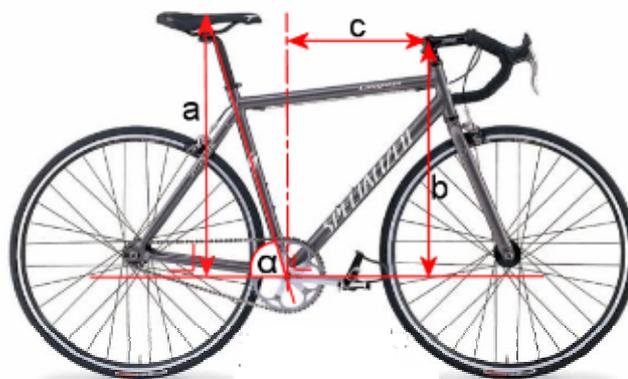
↕ ↑ : 77.2°	↑ : 697
↑ ↕ : 476	↑ : 544

The saddle height (a) is symbolised 

The seating angle (α) by: 

The vertical handlebar position (b) is symbolised with : 

and the horizontal handlebar position (c) by 



7 Specifications

7.1 Technical Specifications

Principle	:	eddy current brake small disk • 430mm.
Mains voltage	:	115-230 VAC (adjustable).
Frequency	:	50 Hz, 60 Hz.
Patient capacity	:	180 kg - 396 lb.
Power consumption	:	120 VA.
Workload	:	8 – 1500 W continuous HYP, 2500 W peak. 8 – 1500 W continuous LIN, 2500 W peak.
Moment of inertia at crank axis	:	24 kgm ² ± 5%
Maximum Torque	:	200 Nm
Device control	:	manual, external analog, external digital.
Accuracy	:	P < 100 W ± 2 W / 100 W < P < 1500 W: ± 2%; P > 1500 W: ± 5%. According to PTB DIN 13405.
Read-out workload	:	digital, 0-2500, resolution 1 W.
Read-out pedaling speed	:	analog 0 -180 rpm or digital 0-255 rpm..
Read-out sitting position	:	on display
Output workload	:	100, 200 or 500 W \triangleq 1 V (max. 2500 W)
Output pedaling speed	:	100 rpm \triangleq 1 V.
Input voltage for external control	:	100, 200 or 500 W \triangleq 1 V (max. 2500 W)
Safety class Excalibur Sport + P	:	I type B, IEC 601-1 chapter 18, 19 and 20.
Safety class Excalibur Sport + B	:	IIa type B, IEC 601-1 chapter 18, 19 and 20.
Leakage current	:	< 0.4 mA.
Isolation resistance	:	> 4 M Ω .
Earthway resistance	:	< 0.2 Ω .
Zero load	:	< 8 W at 60 rpm
Noise level	:	+/- 70 dB at workload 200 W/60 rpm +/-80 cm from crank.

7.2 Fuses

115 V	:	2 x 1,60 A slow.
230 V	:	2 x 0,80 A slow.

7.3 Dimensions

Length	:	130 cm.
Width	:	70 cm.
Height	:	89 cm.

Weight	:	100 kg.
Q factor	:	147 mm
Handlebar width	:	430 mm
Shipping weight	:	100 kg.

7.4 Adjustments

Handlebars	:	229-600 mm horizontal (crank axis-centre of handlebar mountingpoint) and 465-855 mm vertical (crank axis- centre of handlebar mounting point)
Saddle	:	adjustable in height from 550 mm to 938 mm (crank axis- seat top) and horizontal 72- 324 mm (crank axis- seat midpoint). Angle adjustment: $\pm 10^\circ$
Pedals	:	equipped with toe clips (click pedals can be used).

7.5 Options

!	Heart rate	:	928826
!	Blood pressure	:	928818
!	Programmable Control Unit	:	928811
!	Programmable Control Unit with SpO ₂ &HR	:	928841
!	Comfort set (seat, handlebar Corival)	:	925801
!	Pediatric option	:	925804/401068
!	0-watt start up system	:	925805
!	Adjustable pediatric cranks, Range 80-170 mm, step 10 mm.	:	925804
!	Adjustable sport cranks, Range 135-185 mm, step 1 or 2.5 mm	:	925806
!	Cable (RS232 - serial), for connecting the ergometer to a PC:	:	930911
!	Cable (RS232 - serial), for loop-connections to other ergometers	:	930912
!	Pedal Force Measurement (PFM) (built in during manufacturing)	:	925909
!	Wingate software	:	911817
!	PC software LEM (Lode Ergometry Manager):		
	○ LEM	:	928900.
	○ LEM multibike control (4x)	:	928903.
	○ LEM multibike control (8x)	:	928904.
	○ LEM export	:	928908.
	○ LEM Åstrand test available soon	:	928909.
	○ LEM Wingate test available soon	:	928910.
	○ LEM PFM	:	928910.

7.6 *Environmental Conditions*

Temperature range:

Operational : 14 – 40 °C (57 – 104 °F)
Storage : -25 – 70 °C (-13 – 167 °F)

Humidity:

Operational : 30 –90% non-condensing.
Storage : 10 – 95% non-condensing.

Air pressure:

Operational : 70 - 106 kPa.
Storage : 50 - 106 kPa.

The Excalibur ergometer is manufactured in accordance with

: ISO 9001.
ISO 13485
IEC 601-1.
DIN 13405
FDA510K.

8 Communication ports

This chapter describes the communication ports in the back panel of the Excalibur Sport:

! RS232 (two ports for RS232-in and loop connection RS232-out)

! analog in/out

! External RPM/Workload

! Control Unit

8.1 RS232

The Excalibur Sport has two RS232 connectors for loop-connecting a number of Excalibur Sport ergometers (or equivalent Lode devices) and for communication with a personal computer or an ECG device. When the ergometer is controlled externally always use the RS232-in port.

A RS232 cable can be supplied with the Excalibur Sport. Via RS232 an ergometer can be monitored and settings can be entered with a See App. E for protocols and cabling for your controlling device.

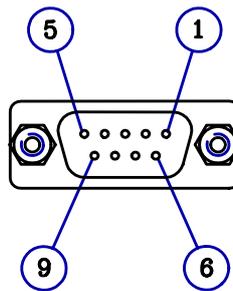


Fig 9: RS232 connector

Pin no.	Signal:	Direction (from Excalibur Sport):	Remark:
1	DCD	--	connected to DTR (4) and DSR (6)
2	TxD	Outgoing	to computer
3	RxD	Incoming	from computer
4	DTR	--	connected to DCD (1) and DSR (6)
5	GND (floating)	--	
6	DSR	--	connected to DCD (1) and DTR (4)
7	N.C.	--	
8	N.C.	--	
9	N.C.	--	

Tab 1: pin layout RS232 connector

8.2 Loop connection

It is possible to control several Excalibur Sport ergometers with one external device using RS232. Connect the RS232-in connector to the external device. Connect the RS232-out connector to the RS232-in connector of the following Excalibur Sport ergometer, and so on. The maximum number of Excalibur Sport ergometers that can be connected in this way is 8. Use the device number option in SYSTEM PARAMETERS to give each Excalibur Sport a unique number. In this way each Excalibur Sport can be controlled separately, using the LEM software.

8.3 RS232 specifications

The setting of the RS232 port when the LODE PROTOCOL is used:

Baud rate : 9600
 Parity : none
 Data bits : 8
 Stop bits : 1

The setting of the RS232 port when the LODE 38k4 PROT is used:

Baud rate : 38400
Parity : none
Data bits : 8
Stop bits : 1

The setting of the RS232 port when the LODE WLP protocol is used:

Baud rate : 9600
Parity : even
Data bits : 7
Stop bits : 2

The settings belong to each protocol. The other protocols have their own specific settings. The RS232 signals CTS, DCD and DSR are hardwired within the Excalibur Sport. The RS232 signals RxD and TxD are isolated through opto couplers from the Excalibur Sport itself. The interface part has its own galvanic isolated supply.

8.4 Analog in/out

This connector can be used to connect the Excalibur Sport to other analog controlling instruments.

Note: analog workload input is only active if the Excalibur Sport is in Analog Mode.

Analog in/out specifications:

- ! Readout RPM 1V = 100 RPM
- ! The workload scaling is selectable, see specifications: 1V $\hat{=}$ 100 W, 1V $\hat{=}$ 200 W, 1V $\hat{=}$ 500 W. The input voltage is limited to maximal 5V. Do not exceed this limit.
- ! The maximal voltage at the analog workload output is maximal 10V. The load scaling adjustment holds both for load input and output.

Note for analog control: With digital control the set workload is exact defined. An analog signal can in principle take every value and it is more sensitive for noise than digital. This can give rise to a small error. In the ergometer it is converted to a digital value and rounded to watts. The actual workload is that one indicated on the ergometer.

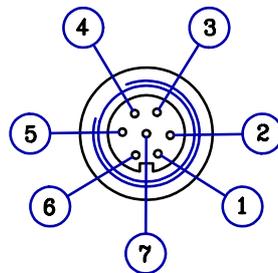


Fig 10: Analog i/o connector

The analog i/o port can also be used for connection of an external heart rate signal either for heart rate readout or as a trigger signal for the BP module (App D).

Pin no.	Signal:	Direction (from Excalibur Sport):
1	+5V	Outgoing
2	GND	--
3	HR_in	Incoming
4	P-in	Incoming
5	+15V	Outgoing
6	P-out	Outgoing
7	R.P.M.-out	Outgoing

Tab 2: Pin layout Analog in/out

A Maintenance

The Lode Ergometer is mechanically and electronically designed for durability and accuracy. This also accounts for the options and add-ons of the device. The frequency of calibration depends on the intensity of usage. As a rule Lode Ergometers are calibrated on an annual basis. Please refer to the Service Manual for specific details on check-up intervals for the Lode Ergometer and its options and/or add-ons.

The safety and integrity designed into the machine can only be maintained when the Lode Ergometer is regularly examined for damage and repair. It is the sole responsibility of the user/owner or facility operator to ensure that regular maintenance is performed. Worn or damaged components shall be replaced immediately or the exercise bicycle removed from service until the repair is made. Only manufacturer-supplied components shall be used to maintain/repair the equipment. Please note these facts.

The dynamic calibration is performed using calibration equipment specially designed by the manufacturer.

A.1 Cleaning

The housing of the Excalibur Sport ergometer and all other external surfaces can be cleaned with a cloth dampened with non-aggressive liquid.

A.2 Replacing fuses

You will not need a certified technician to replace fuses of the Excalibur Sport. Execute the following steps to do this:

Always disconnect the power cord first!

Unplug the mains cable. The fuses are part of the main unit. Unscrew the fuse holders with a screwdriver, replace the broken one and place them back again. Note: make sure that the fuses that are in the Excalibur Sport match the set voltage (115 V: 2 x 1,25 A slow; 230 V :2 x 0,63 A slow).

Contact your local dealer for a maintenance contract or ask Lode:

LODE BV
Service department
Zernikepark 16
9747 AN GRONINGEN
The Netherlands

Tel. +31 50 5712811
Fax. +31 50 5716746

Email: service@lode.nl
Internet: www.lode.nl

B Programmable Display Unit 928811

B.1 Installing the Programmable Display Unit (option 928811)

When the option 928811 is ordered later on, it should replace the standard Control Unit. Replacement should be carried out by service personnel only. Operation of the Programmable Display Unit is described in B.3. Follow the instructions below to replace the Unit:

1. Unscrew the 4 Elot PT Screws of the Ergometer-controller on bottom part side (Fig. 3: Remove the controller top, item 1)
2. Lift the Ergometer-controller top (Fig. 3: Remove the controller top, item 2) a little.
3. Pull the connector of the flatcable (Fig. 3: Remove the controller top, item 4) out of the header (Fig. 3: Remove the controller top, item 3)
4. Take the Ergometer-controller top P-type.

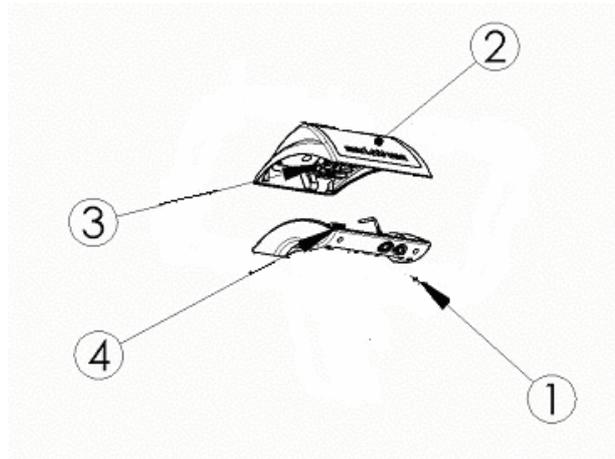


Fig. 3: Remove the controller top

5. Mount the connector of the flatcable to the connector of the P-board of the ergometer controller top P-type. (Fig. 4: Controller top P-type, item 1)
6. Place the controller top on the bottom part of the ergometer-controller.
7. Fasten it with the 4 Elot PT screws

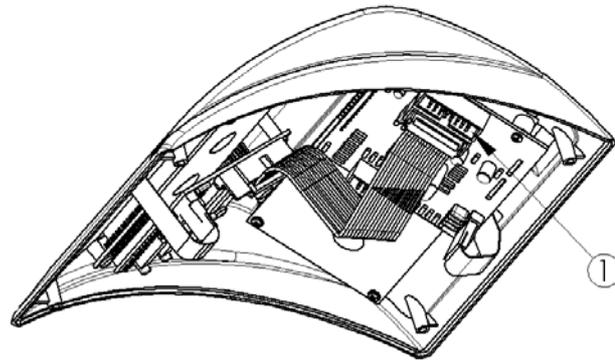


Fig. 4: Controller top P-type

B.2 Control panel Excalibur Sport with Programmable Display Unit (option 928811)

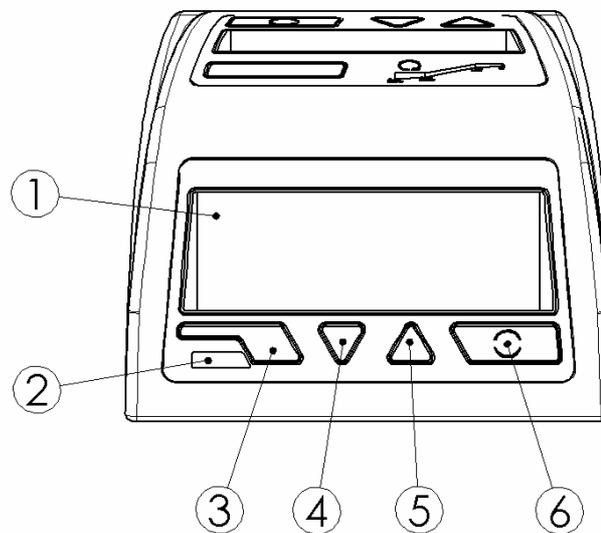


Fig 11: Control Panel Excalibur Sport with Programmable Display Unit

The programmable side of the programmable display consists of the following elements (Fig 11):

1. Display B (4x20 characters) directed to operator
2. Infrared window (only active for option 928820)
3. One-step-back button
4. Down button
5. Up button
6. Confirmation button

B.3 Using the Programmable Display Unit

Check if the ergometer is properly installed.

B.3.1 Startup

In the display of the basic control panel the following appears for a few seconds:



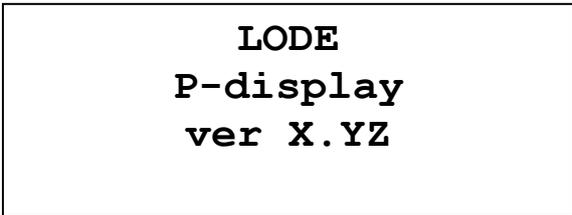
```
LODE ERGOMETER
TBD
```

The name Excalibur Sport is the ergometer name, this depends on your type. On the lower line the version of the embedded software is shown. Followed after a few seconds by:



```
P=    0W    0 rpm
```

At the same time the Programmable Display Unit (Fig 11: Control Panel Excalibur Sport with Programmable Display Unit, item 1) shows for a few seconds:



```
LODE
P-display
ver X.YZ
```

In case the Blood pressure option is available it is followed for approximately 1 second by the text "BPM Initialized" thereby indicating correct operation of the BP device. The SpO₂ comes together with the P-Display. When this option is available correct operation is indicated by the text "SpO₂ Initialized". In case the 0-Watt Start -up System is available the text "0 Watt Initialized" is displayed indicating the 0-Watt Start -up System is detected. When all three options are installed the display shows:

```

      LODE
    BPM Initialized
    SpO2 Initialized
    0 Watt Initialized
  
```

Then the main menu appears:

```

    system parameter
    TERMINAL
    manual
                                     term
  
```

The menu displayed in capitals can be selected. As an additional indication the first four characters of the current menu choice is indicated in the lower right corner. With the ▼▲ keys you can scroll through the other menus and select SYSTEM PARAMETERS, MANUAL, ANALOG or PROTOCOL. With the right () confirmation button the menu in capital can be selected. The left () escape button is used to go back one level in the menu structure.

The ergometer is now ready for use. If nothing appears in the display(s), check whether the power cord and the control unit have been properly connected or contact your supplier.

B.3.2 Menu structure programmable display unit

0. MAIN MENU

- 1. ANALOG
- 1. MANUAL
- 1. TERMINAL
- 1. SYSTEM PARAMETER
 - 2. SET DISPLAY
 - 3. POWER
 - 3. RPM
 - 3. HEARTRATE
 - 3. TORQUE
 - 3. TIMER
 - 3. DISTANCE
 - 3. TARGET HR
 - 3. ENERGY
 - 2. RESISTANCE
 - 2. SET P-SLOPE

- 2. SET MODE
 - 3. HYPERBOLIC
 - 3. HR CONTROLLED
 - 3. LINEAR
 - 3. FIXED TORQUE
 - 3 ISOKINETIC (only available for Excalibur Sport 925900)
- 2. SETTINGS
 - 3. DEFAULT STARTMENU
 - 3. P IN/OUT ANALOG
 - 3. CONTRAST
 - 3. ECG TRIGGER
 - 3. TC_BYTES
 - 3. RS232 PROTOCOL
 - 3. LANGUAGE
 - 3. DEVICE NO
 - 3. ECG START
 - 3. SEATING POSITION (only available for Excalibur Sport 925900)
- 1. PROTOCOL
 - 2. PROTOCOL EDIT
 - 2. PROTOCOL RUN
 - 3. ÅSTRAND PROTOCOL
 - 2. PROTOCOL DELETE

Compared to the standard version the menu PROTOCOL and the submenu ECG START under SETTING are added.

B.3.3 Manual menu

Selecting the manual mode will show you (default) the following display at the programmable display unit:

MANUAL		
P = 0W		0 rpm
♥ = 0/m		
esc	P	esc

or

MANUAL		
P = 0W		0 rpm
♥ = 0/m		
esc	P	BPM

when BP option is available. For BP the same holds for the ANALOG and TERMINAL menu.

With the ▼▲ keys you can increase or decrease the workload. In the middle the adjustable parameter is shown, f.i. the load P.

or

MANUAL		
P = 0W		0 rpm
♥ = 0/m		
esc	P	0Watt

when the 0-Watt Start-up System is available. For this option the same holds for the ANALOG and TERMINAL menu.

With the ▼▲ keys you can increase or decrease the workload. In the middle the adjustable parameter is shown, f.i. the load P.

B.3.4 Analog menu

Selecting the ANALOG menu will show the following screen at the programmable panel:

ANALOG		
P = 0W		0 rpm
♥ = 0/m		
esc		esc

The ergometer is now ready for external control with an analog signal as previously described. See for more information about analog control the standard user guide supplied with the ergometer.

B.3.5 Terminal menu

Selecting the TERMINAL menu will show the following screen at the programmable panel:

TERMINAL		
P = 0W		0 rpm
♥ = 0/m		
esc		esc

The ergometer is now ready for digital external control.

For more information about digital external control using the RS 232 serial port see the standard user guide supplied with the ergometer.

B.3.6 System parameters menu

In the System parameters different ergometry specific settings can be carried out as described previously in the standard user guide. On the programmable control panel you can select the desired menu:

```
set p slope
SET DISPLAY
settings
syst                set
```

The menu displayed in capitals and repeated with an abbreviation under the confirmation button () is the one which can be activated. Selecting one of these menus will show you a more extended display then described in the standard user guide. As you can see with the example of **SET DISPLAY**:

```
POWER
On
esc   Off  On  next
```

Where the function POWER is the same as described previously in the standard user guide (power indication on or off), the button ESC will bring you back to the set display menu. With the ▼▲ keys you can select the power indication to be ON or OFF, and NEXT will bring you to the next item of the SET DISPLAY menu. Beside the parameters RPM, HEART RATE, TORQUE, TIMER and DISTANCE two more are parameters are added: TARGET HEART RATE and ENERGY. An extra third parameter is available when the SpO₂ option is installed.

```
Target HR
On
esc   Off  On  next
```

```
Energy
On
esc   Off  On  next
```

Selecting the target HR parameter will show you the target heart rate programmed in the heart rate controlled protocol beside the actual heart rate. For instance:

2	t=00:48	θ=01:12
P= 23 W		61 rpm
♥= 91/min	t♥=100/min	
rec		rec

Selecting the energy parameter will show you the total amount of mechanical energy delivered by the test subject going into the ergometer in the form of mechanical motion, during the exercise test. For instance:

2	t=00:48	θ=01:12
61 rpm		♥= 91/min
E= 1.43kJ	P= 20W	
rec		rec

Instead of 2 items you can show 4 items out of your selection at once, they will scroll in groups of 2. When you select 4 parameters, there will be no scrolling but a fixation on the display of these parameters. You can program the parameters (also up to 4 without scrolling) at the basic control panel as well, but you have to switch the control over to the basic side first as is described in the next paragraph.

The menu **SETTINGS** will give you the opportunity to select **PROTOCOL** as a default startmenu besides the previously described menus **ANALOG**, **MANUAL**, **TERMINAL** and **SYSTEM PARAMETERS**.

An extra option for the Programmable control unit in the menu **SETTINGS** is the **CONTRAST** adjustment for the P-display.

ecg trigger	
CONTRAST	
p-in/out analog	
sett	Cont

Adjusting contrast shows direct effect on the display.

```
Contrast
contrast = 50%

esc                               ok
```

Only after confirmation with save the new contrast is kept.

Another extra option for the Programmable control unit in the menu SETTINGS is the ECG START selection for the P-display.

```
p-in/out analog
ECG START
Default startmenu
sett                               ok
```

Selecting ok shows.

```
ECG Start
ON

esc      ↑      ↓      ok
```

Only after confirmation with save the new setting is stored. With this option a 400ms pulse is generated 10 s. before the end of a protocol stage to an output on the ergometer. With this output ECG apparatus without a digital interface can be started.

The Programmable control unit offers in the RS232 PROTOCOL sub menu of the SETTINGS menu an extra choice for the ERGOLINE P1 protocol.

```
Lode prot 38k4
ERGOLINE P1
Lode protocol
esc                               ok
```

Selecting ok shows.

```
Save

esc      yes      no      defau
```

Only after confirmation with save the new setting is stored. With this option an ECG apparatus which offers P1 can be connected to the ergometer.

Note: In the original protocol the patient weight and several PWC (Physical - Work Capacity) values must be entered. At the end of the protocol these PWC values were sent to the ECG apparatus. This P1 protocol does not offer PWC calculation. The advantage of this implementation is that any programmed protocol can be executed when using a P1 supported ECG apparatus. PWC's sent to the ECG are all filled out with 0.

B.3.7 Operation from basic control panel

With the basic control panel as described in the standard user guide you had the possibility to switch your KEYBOARD ON or OFF. With the programmable control panel the basic (test subject) side of the unit is default OFF. It is possible to control the ergometer with the buttons of the basic control panel instead of the programmable control panel. You can use this option for service purposes or to program the display of the basic control panel.

During the start up of the ergometer you can press one of the buttons at the basic side to switch operation to this basic control panel, you will then lose the control function of the programmable side. To go back to the default control situation you have to restart the ergometer without pressing any button.

The TEST FUNCTIONS are only available at the basic control panel. They are meant for service personnel only. Contact your supplier in case service of the device is required. **If, accidentally, you get into the TEST FUNCTIONS it can cause damage to the ergometer operation and guarantee will be lost!**

B.3.8 Protocol

In this paragraph the program possibilities under the menu PROTOCOL will be described:

```
run protocol
EDIT PROTOCOL
Delete protocol
prot                edit
```

You can select the menus PROTOCOL EDIT; PROTOCOL RUN and PROTOCOL DELETE.

B.3.8.1 Protocol edit

The menu PROTOCOL EDIT allows you to program new exercise protocols or edit an existing protocol. The memory capacity will allow you to save 50 protocols, all existing of maximal 15 steps each. Pressing this menu will show you the list of protocols which have already been made and the menu New.

```
New
name1
name2
esc                ok
```

With the ▼▲ keys you can select the desired protocol (in this example name1) to edit, select New to program a new exercise protocol:

```

protocol name?
-
esc                next
  
```

Give the protocol a useful name maximal 10 characters with the ▼▲ keys, for instance:

```

Protocol name?
20w min
back              next
  
```

The allowed characters for the name are: '0'..'9', 'a'..'z', 'A'..'Z' and ' '. Move the cursor with the confirmation button () NEXT to the 10th position and the program screen will appear:

```

20w min
Step P=  0W   t=00:00
  1S dP=+050W dt=060s
esc                next
  
```

On top the protocol name is mentioned. The second line will give you information about the status of the programmed momentary workload (P) and time (t). The third line is the actual program line. The stage number with the type of stage is mentioned, followed by the programmable parameters (workload in the above example) and time. Those parameters are displayed as Δ Power (dP) and Δ time (dt). ΔP is the change in power expressed in watts. Δt is the change in time expressed in seconds. Each time you program a stage of the protocol, the ΔP will add or subtract to the momentary Workload (P) shown in the second line. At the same time, the Δt will add to the total exercise time shown in the second line.

The underlined character is the item which can be changed, in the example mentioned above: S. Pressing the ▼▲ keys give you the ability to toggle between the possibilities for programming a stage in a protocol: S, T, L, H, P and Recovery.

<i>S= step</i>	the workload can be adjusted + or – and the duration of this hyperbolic stage can be determined; the load is independent of the RPM.
<i>T= torque</i>	the torque in Nm can be adjusted with a certain duration in this fixed torque stage; load $P = 2 * \pi * N * T$ [W] goes linear with cadence.
<i>L= linear</i>	the workload is coupled with RPM with constant α as the adjustable parameter for the desired duration; load $P = \alpha * N^2$ [W] goes up with square of cadence.
<i>H= heart rate</i>	the workload is regulated as a function of the adjustable heart rate for a certain duration in this heart rate controlled step.
<i>P= proportional</i>	the workload is increased linear as a function of time (ramp protocol). It will take the total duration time to reach the programmed workload.
<i>R= Repeat</i>	repeat steps (up to the maximum workload): you have to enter the workload step and duration only once.
<i>Recovery</i>	the recovery stage is the last stage of a protocol with a fixed workload and an unlimited duration.

Programming is transparent. You can mix all above types of variables, except recovery which is always the last stage, within one protocol.

After the confirmation of the workload during the recovery stage the menu PROGRAM BPM will appear:

```

PROGRAM BPM
Measurement
No BPM
esc                               ok

```

Toggle with the ▼ ▲ keys for the measurement possibilities:

No BPM no BPM module available, select this option when the BPM is not installed, or no automatic blood pressure measurement during this protocol;

Repeat allows you to program a repeat time in minutes during the exercise stages:

```

Program BPM
measurement
repeat
esc                               ok

```

```

PROGRAM BPM
repeat time = 03 min
back                               ok

```

EOS End Of Stage

automatic measurement at every end of the exercise step with the possibility to program the measurement time before the end of the stage.

```

Program BPM
Measurement
EOS
esc                                ok

```

```

PROGRAM BPM
time to EOS = 01 min
back                                ok

```

Recovery time If you have programmed automatic BP measurement in the protocol, either EOS or repeat you get afterwards the possibility to program the repeat time of the BP measurement during the recovery stage:

```

Program BPM
Rec.time = 02 min
back                                ok

```

Leaving the time to programming (repeat, EOS or rec.) is equal to no BP measurement. zero during BP

After the programming of the BPM the menu PROTOCOL will appear again. You can RUN EDIT or DELETE one of the protocols now.

B.3.8.2 Example Programming Protocol

For the purpose of clarification we will program a demonstration protocol with all possibilities. Execute the following steps to get into the programming mode.

1. Select PROTOCOL in the MAIN MENU, confirm ().
2. Select PROTOCOL edit, confirm ().
3. Select New, confirm ().
4. Give a protocol name: test.
5. With the ▼▲ keys you can scroll through the alphabet confirm, use NEXT () to go to the next position.
6. The program screen appears, the underscore showing the programming parameter:

```

test
Step P= 0W   t=00:00
 1S dP=+050W dt=060s
esc                               next

```

7. Confirm the S with NEXT(), use the ▼ key to decrease the workload to 10 watt.

```

test
Step P= 00W   t=00:00
1S dP=+010W dt=060s
back                               next

```

8. Press the confirmation button NEXT until you reach the following screen. Adjust time dt to 60 seconds using the ▼▲ keys.

```

test
Step P= 00W   t=00:00
1S dP=+010W dt=060s
back                               next

```

9. Select T with the ▼▲ keys and adjust the Torque to 10 Nm and the duration to 30 seconds with the same keys. Press the confirmation button.

```

test
Torq P= 10W   t=01:00
 2T T= 10Nm dt=030s
back                               ok

```

10. Select L with the ▼▲ keys and confirm the constant $\alpha=0.041$, change the duration to 10 seconds. Press the confirmation button.

```

test
Lin P= 10W   t=01:30
 3L  $\alpha=.041$  dt=010s
back                               next

```

11. Select H with the ▼▲ keys and change the heart rate in 120/m for a duration of 180 seconds, press the confirmation button.

```

test
HR P= 10W   t=01:40
 4H  ♥=120/m dt=180s
back                               next

```

12. Select P with the ▼▲ keys and change the Workload to 150 in duration of 300 seconds, press the confirmation button.

```

test
Ramp P= 10W   t=04:40
 5P dP=+150W dt=300s
back                               next

```

13. Select P with the ▼▲ keys and change the Workload to minus 60 in 60 seconds, press the confirmation button.

```

test
Ramp P=160W   t=09:40
 6P dP=-060W dt=060s
back                               next

```

14. Select Recovery the ▼▲ keys and change the Workload to 35 and press the confirmation button.

```

test
Rec. P=100W   t=10:40
 7 Recovery P= 35W
back                               next

```

15. After confirmation you will automatically go to the next menu.

```

Program BPM
measurement
no BPM
back                               ok

```

16. Select No BPM when the BPM module is not installed or select Repeat with the ▼▲ keys and choose 2 minutes for the repeat time, confirm with () and choose 2 minutes for the repeat time in the recovery stage. The protocol TEST (with BPM) is ready now, you can go to protocol RUN to test this special protocol (not for normal use).

To edit an existing protocol, you have to select the desired protocol first. You can change the name or confirm the name with NEXT () ten times. Now you can walk through the stages with the confirmation button, until you reach the stage you want to edit. You have to scroll through the total protocol and define the recovery stage before you leave this menu otherwise the changes will not be saved.

B.3.8.3 Protocol Run

The menu Protocol Run is used to select the desired protocol for the exercise test. Select Protocol Run and three previously programmed protocols will appear on screen. To scroll through the total list use the arrows, for instance:

```

10w min
 25w 2 min
ramp 400w
esc                               ok

```

If you want to select e.g. the protocol 10 w min, use the ▼ key until a space appears in front of the name of the protocol (the selectable item is always on the 2nd line) and confirm with ok. The following message will appear on screen:

```

10w min
 1 P=0W t=00:00
 1S dP=+10W dt=060s
esc                               ok

```

This screen is used to check the selected protocol; in this case the name is 10w min: the first step will start with 10 watt for 1 minute. Press the confirmation button to go on:

```

10w min
start at 30 rpm
n= 0/min
esc                               ok

```

The ergometer is ready for use with the selected protocol. When the test subject exceeds the 30 rpm the protocol will run. You will see the following screen:

```

1 t=00:59      θ=00:01
P= 10 W        58 rpm
♥ = 83/min
rec                               rec

```

In this example the screen shows that this is the first step, T= 00:59 so the duration of this step is 59 sec, the timer is showing 1 sec of total exercise time, the timer will stop the registration when the RPM drops below 30. The workload P is 10 watt, the pedalling frequency is 58 RPM, and the heart rate is 83 beats per minute. The three displayed parameters are those selected under SYSTEM PARAMETERS / SET DISPLAY (see System parameters menu B.3.6). At the bottom line you will find the recovery button on the left and right which will bring the workload immediately to the programmed recovery workload. In case the optional BPM is installed you will find instead of the right recovery button a BPM button which allow you to measure the blood pressure with the optional automatic blood pressure module (see the appendix concerning Bloodpressure in this user guide).

The next step will automatically follow:

2	t=00:48	θ=01:12
P=	20W	61 rpm
♥	= 91/min	
rec		rec

The screen shows the second step, the remaining time of this step (T= 00:48), the total exercise time (t=01:12; step 1 and 12 seconds of step 2), the workload in step 2 (P=20 W), the pedalling frequency (61 RPM) and the heart rate of 91 beats per minute.

8.4.1.B.3.8.3.1 Åstrand protocol

The Åstrand protocol is default preprogrammed and can be selected in the menu Protocol Run. The Åstrand protocol is the most often used submaximal protocol for estimation of the VO₂ max, longitudinal follow-up of individuals and for determination of averaged VO₂ max of a group. In order to use this protocol you will need the HR option and enter the age, gender and bodyweight of the test subject. During the Åstrand test the test subject has to cycle for 6 minutes on a submaximal workload. To reach the desired workload the protocol will start default with 50 watt/min. When the target heartrate of 170 minus the age is reached the workload will not increase anymore. This step will be held for 6 minutes. This step is automatically followed by a recovery step. The average heartrate between the 5th and 6th minute (which is supposed to be around 190 minus the age) is used to estimate the VO₂ max afterwards. The following formulas are used:

For male: $VO_{2-maxmale} = (174.2 * W1 + 4200) / (103.2 * HR_{average} - 6299)$ [l/min]

For female: $VO_{2-maxfemale} = (163.8 * W1 + 3780) / (104.4 * HR_{average} - 7514)$ [l/min]

Correction factors for age are if age is below 17 years: $corr_lftage < 17 = -0.027 * age + 1.461$

and for age equal or above 17 years: $corr_lftage \geq 17 = -0.008 * age + 1.134$

which gives for the VO₂-max value: $VO_{2-maxage_corrected} = VO_{2-max} * corr_lft$

VO₂-max values are often expressed in [ml/(min.kg)] so the weight [kg] of the test subject needs to be incorporated, resulting in:

$VO_{2-maxper_kg} = 1000 * VO_{2-max} / weight$ [ml/(min.kg)]

Execute the Åstrand protocol

The menu Protocol Run is used to select the Åstrand protocol for the exercise test. Select Protocol Run and three previously programmed protocols will appear on screen. To scroll through the total list use the arrows, for instance:

```
astrand
 25w 2 min
10 w min
esc                               ok
```

If you want to select e.g. the protocol Åstrand, use the ▼ key until a space appears in front of the name of the protocolname (the selectable item is always on the 2nd line) and confirm with ok. The following message will appear on screen:

```
Astrand protocol
 Offset = 50 W
esc                               ok
```

This screen is used to check the workload steps you can choose with the ▼ key between 50 and 25 W. The offset is defining the first workload and the next steps, starting with 50 watt and steps of 50 watt, or starting with 25 watt and steps of 25 watt. Confirm with ok.

```
Astrand protocol
 Gender = m
esc                               ok
```

This screen is used to select the gender of the test subject, with the ▼▲ keys. It is important to select the gender because it is used in the formula's. Confirm m for male or f for female with ok.

```
Astrand protocol
 Age = 40
esc                               ok
```

Like the gender the age has to be filled in with the ▼▲ keys, the age is used for the target heartrate (170 minus age) and for age+correction of the estimated Vo2 max. Confirm the correct age with ok.

```
Astrand protocol
Weight = 65
esc                               ok
```

The bodyweight can be selected in this screen with the ▼▲ keys. The bodyweight is used to calculate the Vo₂ max expressed in [ml/(min.kg)]. Confirm the correct bodyweight in kg with ok.

```
Astrand protocol
start at 30 rpm
n= 0/min
esc                               ok
```

The ergometer is ready for use with the selected protocol. When the test subject exceeds the 30 rpm the protocol will run. You will see the following screen:

```
                                θ=00:21
P= 50 W                        58 rpm
♥ = 83/min
rec                             rec
```

In this example the screen shows that this is the 50 watt step, the timer is showing 21 sec of total exercise time. The workload P is 50 watt, the pedalling frequency is 58 RPM, and the heart rate is 83 beats per minute. The three displayed parameters are those selected under SYSTEM PARAMETERS / SET DISPLAY (see System parameters menu B.3.6). At the bottom line you will find the recovery button on the left and right which will bring the workload immediately to the programmed recovery workload. In case the optional BPM is installed you will find instead of the right recovery button a BPM button which allow you to measure the blood pressure with the optional automatic blood pressure module (see the appendix concerning Bloodpressure in this user guide).

The next step will automatically follow as long as the heartrate of the test subject is below 170 minus the age.

```

                                θ=01:12
P= 100W                        61 rpm
♥ = 91/min
rec                             rec

```

As soon as the target heartrate is reached the 6 minute Åstrand step is starting, the workload will not increase anymore. During the last 2 minutes of the Åstrand step the time is counted down

```

t=01:59                        θ=08:21
P= 150W                        64 rpm
♥ = 156/min
rec                             rec

```

In this example the Åstrand step has been 150 watt, the step will continue for 1.59 min. The heartrate of 170 minus the age has been reached 4 minutes ago. The next step is the recovery and this will automatically follow .

```

recovery
Pa= 150W ♥a = 156/min
Vo2 m = 2.63 l/min
esc

```

The estimation of the Vo2 max is given in l/min. To get the Vo2 max expressed in [ml/(min.kg)] press the ▲key.

```

recovery
Pa= 150W ♥a = 156/min
VO2 m= 37.5 ml/min/kg
esc

```

B.3.8.4 Blood Pressure Measurement

When your controller is extended with the optional automatic blood pressure module you can either program a measurement interval (see Protocol edit B.3.8.1 and Example Programming Protocol B.3.8.2) or press the () BP button (see appendix on BP measurement) to start manual a BP measurement when running a protocol and the following might appear on screen. You see the selected display parameters.

```

          BPM
P= 30W           60 rpm
♥ = 114/min
PROT   dis   ►

```

Pressing PROT (protocol) will bring you back to the normal exercise protocol screen. Pressing DISP (▼▲) will allow you to toggle between the BP parameters and de default selected parameters. START will start the blood pressure measurement. Pressing DISP will show as next display the actual pressure p on the second line:

```

          BPM
p = 123 mmHg
P= 30W           60 rpm
PROT   dis   ►

```

On the third line are still the selected parameters. Pressing DISP again will show as next display the actual pressure p.

```

          BPM
p = 123 mmHg   ♥♫
P= 30W           60 rpm
PROT   dis   ►

```

Whenever the test subject is allowed to or has to stop the exercise test, the recovery button has to be pressed the following will appear on screen:

```

Rec P= 50W     t=10:30
P= 50W         60 rpm
♥ = 174/min
esc           esc

```

In this example the recovery phase will bring the workload down to 50 watt. The timer is showing 10:30 seconds and will go on with the registration during the recovery as long as the RPM is above 30 (the BPM can still be measured when BPM is displayed at the confirmation button). To stop the recovery phase press the ESC button to go back to the PROTOCOL menu. In MANUAL, TERMINAL or ANALOG the BP function is the same as described above.

B.3.8.5 Protocol delete

This function allows you to delete a protocol. Select the protocol which you do want to remove (in this example TESTPROTOCOL) and confirm with OK. The following screen will appear:

```
testprotocol
Delete?

esc                ok
```

Confirm with OK when you agree and the message [deleted] will appear on the screen.

C Heart rate option 928826

C.1 Connecting the Heart rate system (option 928826)

To install a heart rate option purchased afterwards, follow the instructions given below. The heart rate option should be mounted to the analog i/o connector. Position the receiver within 1 meter of the test subject heart position.

C.2 Using the Heart rate option

The heart rate option is automatically recognized by the ergometer. The Polar belt should be mounted at the test subject's heart height around the chest with Polar trade mark pointing forwards from the middle of the chest. The belt should not be too loose. If you have a weak signal, check following tips:

- Wet the contacts on the right and left backside of the Polar belt for good contact
- Stay near the receiver (within a range of 0,8 meter)
- Due to the integration measurement principle it can take a few seconds before the readout on the display shows the correct value. Be patient.
- The test subject should be positioned in such way that a straight virtual line can be drawn between the Polar trade mark on the belt *and the receiver inside the display unit, or placed in front of the Test subject.*
-

C.3 Instructions for installation

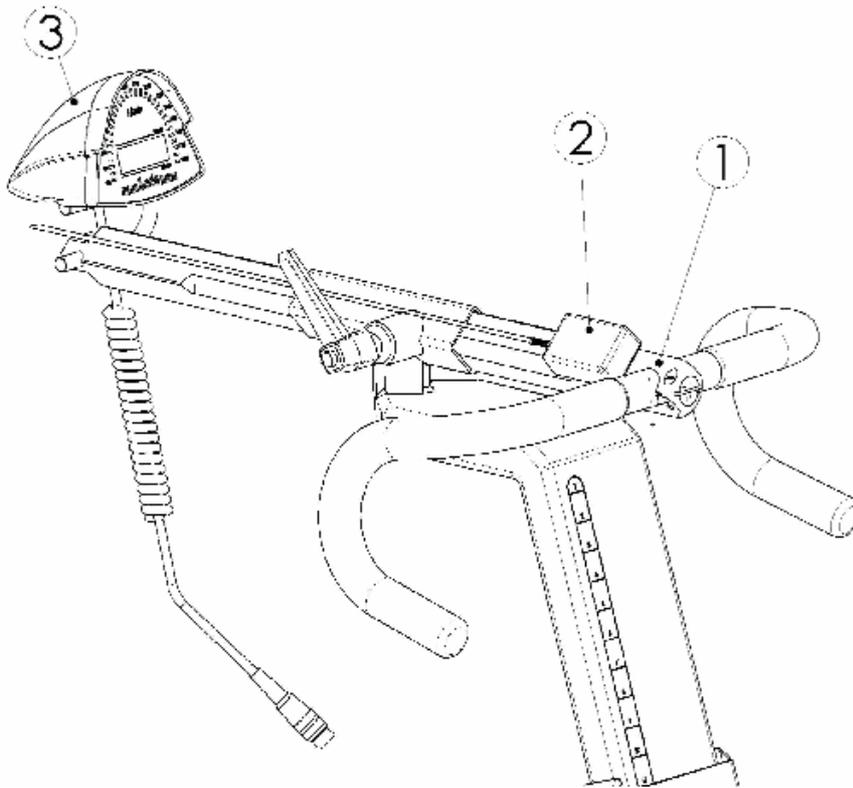


Fig 12: Heart rate receiver placement

1. Handlebar
2. Heart rate receiver box
3. RPM set: display for RPM and Workload

The following steps have to be executed to install the Excalibur Sport ergometer properly:

1. Place the ergometer in its operating location.
2. Check (with your supplier) whether the voltage set for the ergometer is set correct.
3. Place the control unit in its operating location
4. Insert the connector of the ergometer cable into the control unit connector of the ergometer (item 2 Fig. 9 Main unit panel connections).

5. Connect the power cord first to the socket of the ergometer (item 4 Fig. 9 Main unit panel connections) and then connect it to the power source (wall outlet or instrument outlet).
6. Ensure that the cables are tied away from any moving parts. Make sure that the test subject can not accidentally kick or trip over cables.
7. Push the on/off switch (Fig. 9 Main unit panel connections, item 3). The indicator light in the switch lights up.
8. In display A the following appears for a few seconds:

**EXCALIBUR SPORT
VER X.YZ**

In case the BP option is available it is followed for appr. 1 second by:

**EXCALIBUR SPORT
BPM initialized**

Then the main menu appears:

**EXCALIBUR SPORT
MAIN MENU**

The ergometer is ready for use.

If nothing appears in the display(s), check whether the power cord has been properly connected or contact your supplier.

D Blood pressure option 928818

With option 928818 your ergometer is able to perform stand alone or external controlled blood pressure measurements. Keep in mind the fact that automatic blood pressure measurements during arm exercise is not possible due to movement artefacts. After installation the BP module is recognized automatically at start-up of the ergometer, indicated by the following screen for a few seconds:

**LODE ERGOMETER
TBD**

D.1 Using the BP system

Caution: Carefully read the instructions in Appendix D.2 Patient Hook-up and D.2.3 Notes on blood pressure measurement before continuing. Only well trained medical personnel, familiar with BP measurement, should operate the BP system.

When you are in the MANUAL, TERMINAL or ANALOG mode you can go to the BP measurement by pressing () button. The following menu appears:

**P= 90W 69 rpm
dis ► TERMINAL**

In the upper line of the display still your selected readout parameters appear. The buttons below have the following functions:

▼ **dis**: Toggle the display between your readout parameters and the pressure p [mm Hg]. Pressure is indicated as lower case p and workload with upper case P.

**P = 0 mm Hg
dis ► TERMINAL**

▲ ►: The BP measurement starts:

**P = 120 mm Hg
dis ■ TERMINAL**

▲ ■: The BP measurement stops: With the same button the BP can be aborted at any time and the pressure will be released.

() **MANUAL / TERMINAL / ANALOG**: Return to the operation mode where you started from (MANUAL, TERMINAL or ANALOG).

The cuff inflates to 180 mm Hg, if it is the first BP measurement of this patient. 180 mm Hg is the initial maximum of the pressure. For each subsequent BP measurement, the last measured SYSTOLIC value +50 mm Hg is used as a maximum inflation limit. Be aware that in case of an error (D.3) the inflate limit can go up to 260 mmHg worst case. Above 300 mm Hg, or if a measurement lasts longer than 180 seconds, the hardware releases pressure immediately for safety reasons. Deflation is done 40 mm Hg below the last measured DIASTOLIC pressure. The used deflate rate is approximately 4 mm Hg/heartbeat.

A list of most occurring warnings and errors is given in D.3 Abort codes BP system. The built-in BP module offers, in case of malfunction or poor performance, the possibility to make error codes visible. These are the so-called TC bytes. They have to be switched on under SYSTEM PARAMETERS/SETTINGS/TC_BYTES (6.4.6). When the test codes are ON two more displays are available after BP measurement:

1. TC bytes 0,1,2,3:

00H	04H	c0H	00H
dis	▶		MANUAL

2. TC bytes 4,5,6,7:

00H	00H	0aH	00H
dis	▶		MANUAL

Caution: The interpretation of the error codes should be done only by experts. Ask your supplier for more information.

D.2 Patient Hook-up

Correct patient hook-up is very important. Experience has shown that a lot of troubles can be avoided when the rules below are kept in mind. Especially BP measurement using Korotkoff tones under stress requires accurate preparation.

D.2.1 Apply the cuff

On the inside of the upper arm you can feel the brachial artery. Palpate the brachial artery to ensure proper placement. The best place for the microphone is where you can most clearly feel the pulse (Fig. 16 Palpating the arm). Upper clothing should be taken off! Pulled up garments should not jam the upper arm.

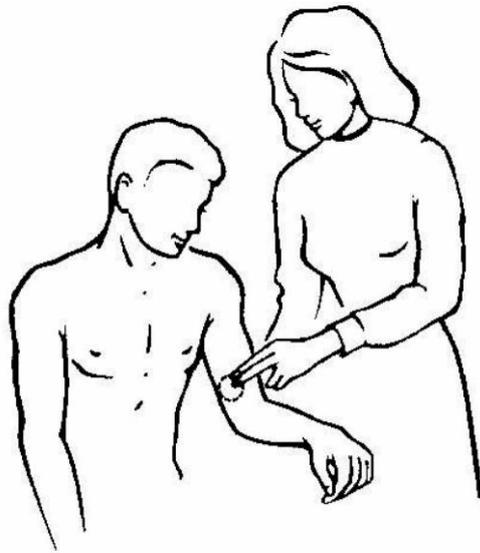


Fig 13: Palpating the arm

D.2.2 Position of the cuff

The cuff should be placed on the upper arm, so that it is positioned about 2 cm above the elbow close to the heart level (Fig 14: Cuff position). Place the microphone on the position that you palpated.

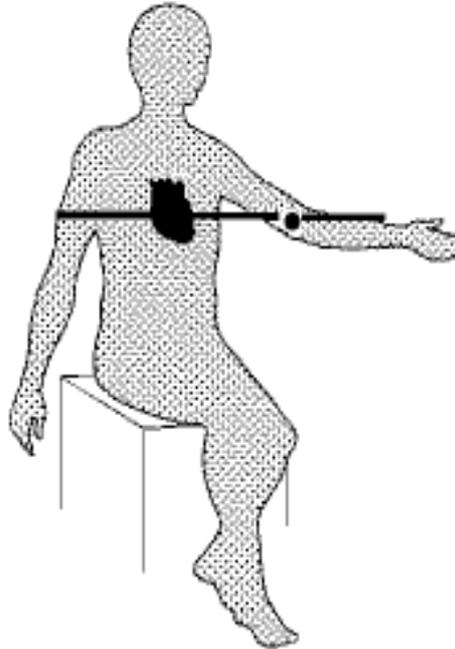


Fig 14: Cuff position

Caution: Never place the cuff so that the microphone is located in the elbow. Pull the cuff so tight, that it neither moves nor ties off the arm of the patient. By fasten the cuff too tight or too loose, error measurements are caused.

Wrap the end of the cuff around the upper arm and close the Velcro fastening (Fig 15: Mounting the cuff).

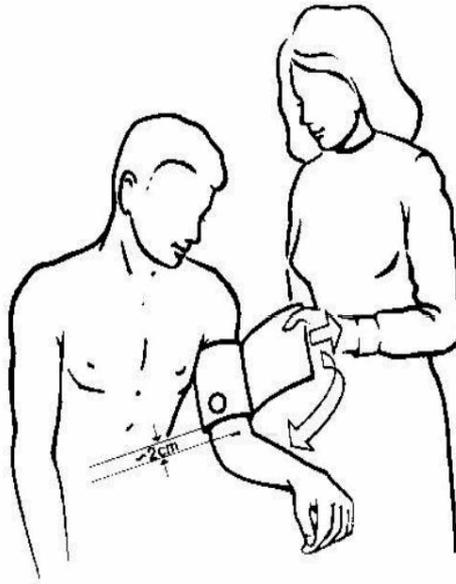


Fig 15: Mounting the cuff

Ensure that the air hose from the monitor to the cuff is not compressed, crimped or damaged. During ergometry the air hose should be handled and attached in such a way, that vibrations and movement artefacts are avoided. Use the ring strap to fix the tubes to the wrist to avoid tensions on the cuff due to moving and pulling tubes.

D.2.3 Notes on blood pressure measurement

It is important to select the cuff size that is appropriate to the diameter of the patient's upper arm. Wrap the cuff around the arm making sure that the microphone is aligned over the brachial artery as shown in Fig 15: Mounting the cuff.

Ensure that the air hose from the ergometer to the cuff is not compressed, crimped or damaged. The microphone should be at heart-level during the measurement (Fig 14: Cuff position). Automatic blood pressure measurement, particularly with ergometry conditions, has to comply with some rules to guarantee reliable measurement results.

To apply the cuff in the correct way is an essential condition.

During the measurement, which starts with inflation, the arm with the cuff should be kept in rest, either hanging or leaning as relaxed as possible.

The intervals of the measurements should not be too short. Intervals of 2 minutes and more result in long pauses between the stenoses, so that venous congestion and artiospasm can be avoided.

D.3 Abort codes BP system

Prior.	Error message	Display	Possible error cause
1	ACHECK ECG SIGNAL ≅	0 / 0 mmHg	! ! ECG trigger not connected. ! ! ECG trigger properties not correct. ! ! ECG trigger polarity not correct. ! ! QRS pulse width smaller than 10 ms.
2	ACUFF OVERPRESSURE ≅	0 / 0 mmHg	! ! Strong arm movements during the blood pressure measurement. ! ! Air hose is bent or blocked.
3	AAIR LEAK ≅	0 / 0 mmHg	! ! Cuff is loose or not connected. ! ! Air hose or air-bubble leak. ! ! Air hose not connected.
4	ASERVICE REQUIRED ≅	BP value	! ! Fatal error ...Get in touch with the company Lode.
5	ACHECK ECG/ MICROPHONE ≅	BP value	! ! Poor patient hook-up (irregular ECG-signal) or poor trigger signal. AND ! ! Abnormal microphone-signal or damaged microphone.
6	ACHECK MICROPHONE ≅	BP value	! ! Wrong Microphone placement or defect microphone.
7	ACHECK ECG/ ARTIFACT ≅	BP value	! ! ECG trigger signal failed during blood pressure measurement. Bad or irregular ECG-signal during the blood pressure measurement. AND ! ! Excessive movements of the patient during the blood pressure measurement.
8	AARTIFACT/ARM MOVEMENT ≅	BP value	! ! Excessive movements of the patient during the blood pressure measurement.
9	ACUFF INFLATION TOO LOW ≅	BP value	! ! Maximum cuff pressure adjusted too low. ! ! Inflation pressure adjusted too low. Repeat measurement.
10	None	BP value	

D.4 Cleaning and disinfection of the cuff

Entry- and connection cables, like the air-hose from the cuff should not be sterilized in hot steam or cold gas or plunged in disinfectants.

D.5 Cleaning of the cuff:

For the cleaning of the cuff, you can take out the air-hose (Fig 16: Air-hose removal).

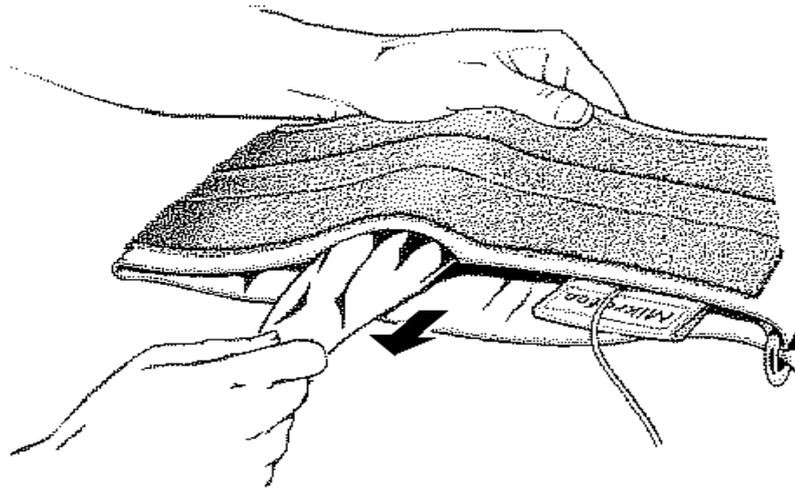


Fig 16: Air-hose removal

Now you can open the Velcro fastening of the cuff and take out the microphone.

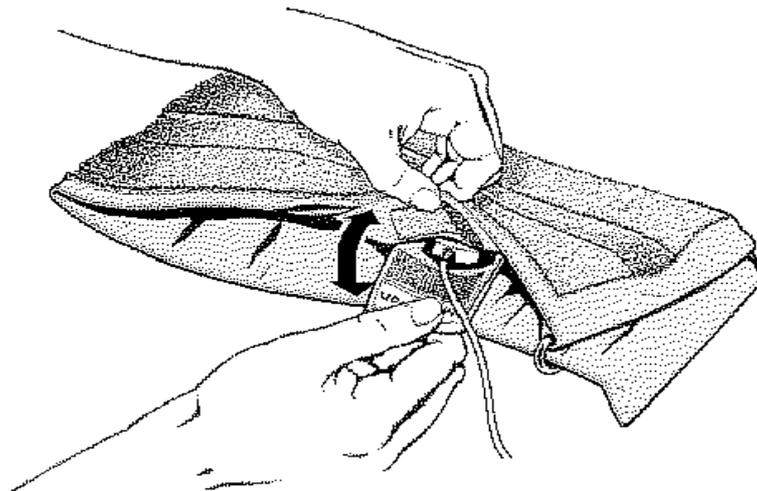


Fig 17: Microphone removal

The cuff can be washed at 30° C (Fig 18: Wash indications). The air-hose can be cleaned with mild non-alcoholic disinfectant. There may not remain any liquid in the air-hose afterwards.

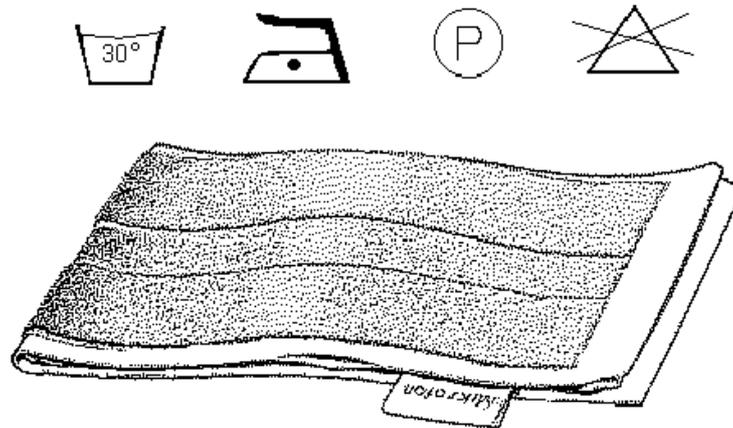


Fig 18: Wash indications

The air-hose can easily be put back in the cuff, if beforehand both ends are rolled up to the hose entry.

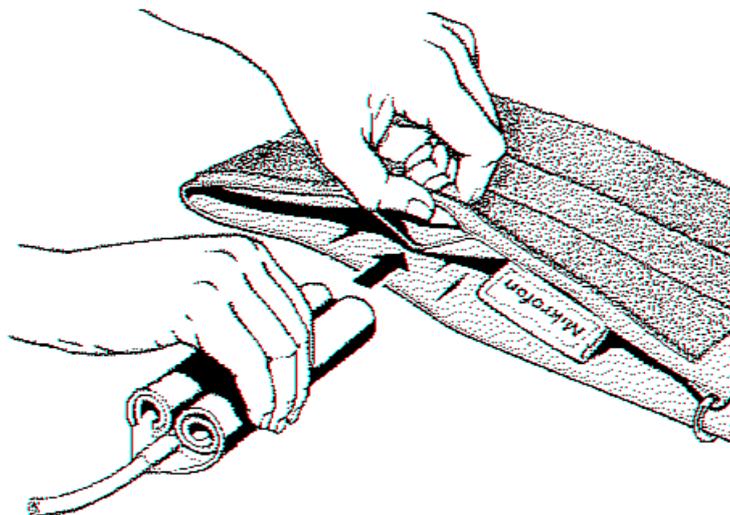


Fig 19: Placing the air-hose

Slip the microphone back in the bag (Fig 20: Placing the microphone) and close the Velcro fastening.

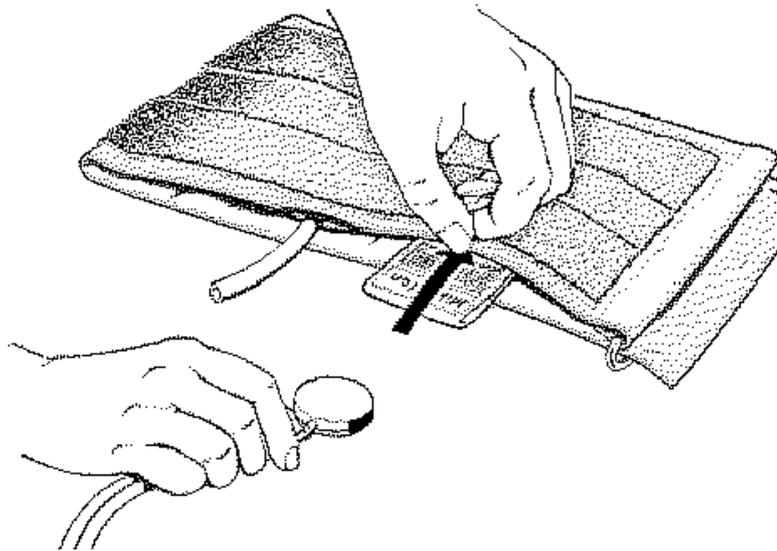


Fig 20: Placing the microphone

D.6 Installing the BP cuff

To install a B option purchased afterwards, follow the instructions given in the service manual or contact your supplier.

Installation of the BP module itself shall be done by service personnel only.

E SpO₂ option 928841

With option 928841 your ergometer is able to perform stand alone or external controlled measurement of functional oxygen saturation of arterial hemoglobin (%SpO₂) and pulse rate (BPM) for adult and pediatric test subjects.

E.1 Specifications

Oxygen Saturation Range	:	0 to 100%
Pulse Rate Range	:	18 to 300 pulses per minute.
Measurement Wavelengths Red Using Lode B.V. supplied Sensors	:	660 nanometers @ 3mW Nominal
Infrared	:	910 nanometers @ 3mW Nominal
Accuracy		
SpO ₂ (70-100%) (± 1 SD) ¹⁾	:	No Motion - Adults, Pediatrics ± 2 digits.
	:	Motion - Adults, Pediatrics ± 3 digits
		Low Perfusion - Adults, Pediatrics ± 2 digits
Heart Rate	:	No Motion (18 - 300 BPM) - Adults, Pediatrics ± 3 digit
	:	Motion (40 - 240 BPM) - Adults, Pediatrics ± 5 digits
	:	Low Perfusion (40 - 240 BPM) - Adults, Pediatrics ± 3 digits
Temperature		
Operating	:	0°C to +50°C
Non Operating	:	-20°C to +50°C
Humidity		
Operating	:	10 to 90% Non Condensing
Non Operating	:	10 to 95% Non Condensing

¹⁾ Standard Deviation is a statistical measure: up to 32% of the readings may fall outside these limits.

E.2 Precautions for Use

Contraindications

- Do not use the SpO₂ option in an MRI environment.
- Keep in mind the fact that SpO₂ measurements during arm exercise is not possible due to movement artifacts.
- Do not attach the pulse oximeter to the same limb as the Cuff of the blood pressure monitor or any other blood flow restrictor. Loss of monitoring can occur due to the hindering of pulse measurement.

Warnings

- Use only pulse oximeter sensors supplied by Lode B.V.. These sensors are manufactured to meet the accuracy specifications for pulse oximeter hardware. Using other manufacturers' sensors can result in improper pulse oximeter performance.
- Explosion Hazard: Do not use the SpO₂ option in an explosive atmosphere or in the presence of flammable anesthetics or gases.
- Loss of monitoring can result if any objects hinder the pulse measurement. Ensure that no blood flow restrictors (e.g., blood pressure cuff) hinder pulse measurements.
- As with all medical equipment, carefully route cables and connections to reduce the possibility of entanglement or strangulation.
- This device does not meet defibrillation-proof requirement per IEC 60601-1: 1990, clause 17.h.
- Operation of this device below the minimum amplitude of 0.5% modulation may cause inaccurate results.

Cautions

- The accuracy of the SpO₂ measurement may be affected if the total cable length (including extension cables) is greater than 3 meters.
- This pulse oximetry system is designed to determine the percentage of arterial oxygen saturation of functional hemoglobin. Significant levels of dysfunctional hemoglobin, such as methemoglobin, might affect the accuracy of the measurement.
- The SpO₂ option has motion tolerant software that minimizes the likelihood of motion artifact being misinterpreted as good pulse quality. In some circumstances, however, the SpO₂ option may still interpret motion as good pulse quality.
- Inspect the sensor application site at least every 6 to 8 hours to ensure correct sensor alignment and skin integrity. Patient sensitivity may vary due to medical status or skin condition. Discontinue use of adhesive tape strips if the patient exhibits an allergic reaction to the adhesive material.
- This module complies with International Standard EN 60601-1-2:2001 for electromagnetic compatibility for medical electrical equipment and/or systems. This standard is designed to provide reasonable protection against harmful interference in a typical medical installation. However, because of the proliferation of radiofrequency transmitting equipment and other sources of electrical noise in healthcare and other environments, it is possible that high levels of such interference due to close proximity or strength of a source might disrupt the performance of this device. Medical electrical equipment needs special precautions regarding EMC, and all equipment must be installed and put into service according to the EMC information specified in this manual.
- Portable and mobile RF communications equipment can affect medical electrical equipment.

For more information about required safety and regulatory requirements for medical devices, refer to EN865 and IEC 60601-1.

E.3 Using the SpO₂ Option

The SpO₂ is come together with the P-Display. After startup the ergometer indicates correct operation of the SpO₂ device by showing the following screen for a few seconds:

```

LODE

SpO2 Initialized
```

When in the sub menu SET DISPLAY of the SYSTEM PARAMETER SpO₂ is selected to be displayed. As follows,

```

SpO2
On

Esc      Off On      next
```

The following can be displayed.

```

TERMINAL
P=      0W           0 rpm
♥= 55/min   SpO2= 98
ecs                esc
```

The SpO₂ option also measures the heart rate and this value is displayed when this display setting is selected. The heart rate value measured by the SpO₂ option can not serve as a trigger source for the blood pressure option.

The SpO₂ option also report errors due to bad signals or improper handling. The following is displayed when the sensor is not connected:

```

TERMINAL
P=      0W           0 rpm
♥= 55/min SpO2= SNSD
ecs                esc
```

The following errors can be displayed:

- **SNSD** Sensor Disconnect – An absence of signal, meaning the sensor is gone
- **OOT** Out Of Track – An absence of consecutive good pulse signals

- **MIDA** SpO2 could not be calculated, missing data indicator
- **ARTF** Artifact – A detected pulse beat didn't match the current pulse interval
- **MPRF** Marginal Perfusion – Amplitude representation of medium signal quality (holds for entire duration)
- **LPRF** Low Perfusion – Amplitude representation of low signal quality holds for entire duration)

F 0 Watt Start-up System 925805

With option 925805 your ergometer is able to start the ergometer without load (0 watt) at a preset pedal speed (rpm). You can choose any pedal speed between 30 and 80 rpm. The number of revolutions is increased from 0 to the required rpm by means of a motor drive. With this option there is no energy-loss due to the start-up phase. This option has to be built-in in the ergometer while manufacturing and cannot be added later on.

F.1 Using the 0 Watt start-up system

When you are in the MANUAL, TERMINAL or ANALOG mode you can go to the 0 watt by pressing the () (enter) button. The following menu appears (Terminal):

50 rpm	0 rpm
RPM	TERMINAL

In the upper left the target rpm is shown. The default value is 50. The current rpm is shown on the upper right. The maximum target rpm is 80 the minimum value is 30 rpm. With the up and down key's the target rpm can be changed to the desired value. When entering the menu the system is not started but begins on the first button press of the up or down key. When the current rpm is over the target rpm the system is released. And the system stops. The menu also returns to the previous selection (Terminal).

The test subject can now start pedaling.

F.2 0 Watt Start-up system with P-display

In case the 0-Watt option is available it is followed for approximately 1 second by thereby indicating the device is detected.

LODE
0 Watt Initialized

When using the 0 Watt option from the P-display it can also be used from TERMINAL, MANUAL or ANALOG mode. When selected the following is shown (manual case).

MANUAL	
P = 0W	0 rpm
♥ = 0/m	
esc	P 0Watt

Pressing the Enter key (0Watt) will show the operating menu for the 0 Watt option:

0 WATT STARTUP SYST.			
50 rpm			0 rpm
manual	↓	↑	manua

The default target rpm (50) is shown on the left. The current rpm is shown on the right. With the up and down key's the target rpm can be changed to the desired value. On the first button press the 0 Watt startup system starts, when the current rpm is above the target rpm the system is released and the display returns to the previous selection (Manual).

G RS232 Connections

Your ergometer can be connected to almost all available external equipment. In the overview that follows, you can find an overview of the manufacturers of this equipment, the models and the protocol that should be selected in your ergometer. Please keep into account that this list is not exhaustive and that it is possible to connect your Lode ergometer to equipment that is not listed hereunder. If you want to connect your Lode ergometer to external equipment that is not mentioned in the list, please contact your local distributor for the correct communication protocol.

G.1 Overview

Manufacturer	External Device	RS232 Protocol Lode Ergometer
Agilent	HP StressWriter M2488A	Lode WLP
Bosch	EKG 506 DS	Bosch EKG506DS
BTL	BTL-08PC	LODE Protocol
	BTL-08 Win Ergo software	LODE Protocol
Burdick / Spacelabs	Spacelab	LODE Protocol
	Burdick Quest	P10
Cambridge Heart	CH2000	LODE Protocol
Cardioline	Prima Stress ECG	P10
	ECT WS 2000	P10
	Ergo Card	P10
CogniMed	Therapiemonitor TM Soft/Hardware	LODE Protocol
Cortex Biophysik GmbH	MetaLyzer	LODE Protocol
	CMS	LODE Protocol
Cosmed S.r.l.	QPFT Ergosystems	LODE Protocol
	B2Quark	LODE Protocol
Customed GmbH	CustoCard M	LODE Protocol
Daedalus / Cardiette (H&C Medical)		ECG4
Dr. Vetter	Dr Vetter PC-EKG	P10
Esaote	P8000 Power	P10
	P210	P10
	Formul@	P10
	Archimed	P10
	Archiwin	P10
Ferraris / Delmar / Reynolds / ZAN / Morgan	Cardio Direct	P10
	Cardio Collect	P10
	600 Ergospirometry System	LODE Protocol
	EX 670	LODE Protocol

Fukuda Denshi Co. Ltd.	FX 4010 + ES10	P10
	Cardimax FX-7402	P10
GEMS IT	CASE 12, 15, 16 (with Ergometer + BPM)	P10
	CASE 8000	P10
	Cardiosoft	P10
	Cardiosys	P10
	MAC1200ST	P10
	MAC5000	P10
	Max I + Corival 400	P10
	Max I + Ergometer + BPM	P10
	Max - PE	P4
Innomed Medical Inc.	Heartscreen 112DT	LODE Protocol
	Cardio PC/E	LODE Protocol
Medical Graphics Corporation	Cardio Perfect	LODE Protocol
	CPX/D System	LODE Protocol
	CPX/MAX/D	LODE Protocol
	CardiO2/CP	LODE Protocol
	Cardio 2/CPX/D	LODE Protocol
	Medgraphics Profiler EX	LODE Protocol
MedIT AS	MeditSense 100	LODE Protocol
Beijing Meigaoyi Co. LTD	ECG LAB Treadmill Stress System	LODE WLP
Mesa Medizintechnik GmbH	Cardiax PC EKG	LODE Protocol
Mortara	X-scribe II	LODE Protocol
Neurosoft	Poly Spectrum Velo	P10
Nihon Kohden	Cardiofax V - ECG - 93xx series	P10
Norav	PC-ECG 1200	LODE Protocol
Phillips Medical Systems	Cambridge Heart CH 2000 Stress System	P10
	Stress Vue	P10
Progetti Srl.	Custo Card M Stress Test System	P10
Pulse Biomedical Inc.	QRS Card Software	P10
Quinton Inc.	Q-Stress	LODE Protocol
Schiller AG	Cardiovit AT-104 PC	Schiller
	AT-10	Schiller
	AT-10 Plus	Schiller
	CS 100	Schiller
	CS 200	Schiller
	AT-60	Schiller
	AT 110	Schiller
Schwarzer GmbH	Cardos 12-5	P10
Siemens	Megacard	P10
VIASYS Healthcare GmbH	Vmax Spectra	P10

Sensormedics	Vmax 29	P10
	Vmax analog	P10
	Sensormedics Cardiosoft + Corina V4.2	P10
Sensormedics	Oxycon Pro	Lode WLP
	Oxycon Alpha	Lode WLP
	Oxycon Beta	Lode WLP
Welch Allyn Cardio Control	Cardioperfect 2001 (CP comcard ISA)	LODE Protocol
	Cardioperfect 2001 (Unilink USB or CP comcard PCI)	LODE Protocol

A Lode ergometer is default shipped with the LODE RS232 communication protocol. You can change the RS232 protocol by following the procedure below:

- Switch on the ergometer and press enter.
- You will be in the "MAINMENU"
- Select, by using the up/down keys, the menu "SYSTEM PARAMETER" and press enter
- Select, by using the up/down keys, the menu "SETTINGS" and press enter
- Select, by using the up/down keys, the menu "RS232 PROTOCOL" and press enter
- Select, by using the up/down keys, the desired protocol and press enter.
- Save the selected RS232 protocol or restore the default RS232 protocol, which is also the LODE PROTOCOL.
- Switch off the ergometer.

H Electromagnetic Compatibility (EMC)

The Lode equipment is intended for use in the electromagnetic environment specified below. It is the responsibility of the customer or user to ensure that the Lode equipment is used in such an environment.		
Emissions Test	Compliance	Electromagnetic Environment – Guidance
RF emissions CISPR11	Group 1	The equipment uses RF energy only for its internal function. Therefore, its RF emissions are very low and are not likely to cause any interference in nearby electronic equipment.
RF Emissions CISPR 11	Class B	The equipment is suitable for use in all establishments including domestic establishments and those directly connected to the public low-voltage power supply network that supplies buildings used for domestic purposes.
Harmonic Emissions IEC 61000-3-2	Class A	
Voltage fluctuations / Flicker emissions IEC 61000-3-3	Complies	

The Lode equipment is intended for use in the electromagnetic environment specified below. It is the responsibility of the customer or user to ensure that the Lode equipment is used in such an environment.			
Immunity Test	IEC 60601-Test Level	Compliance Level	Electromagnetic Environment - Guidance
Electrostatic discharge (ESD) EN 61000-4-2	± 6 kV contact ± 8 kV air	± 6 kV contact ± 8 kV air	Floors should be wood, concrete or ceramic tile. If floors are covered with synthetic material, the relative humidity should be at least 30%.
Electrical fast transient/burst EN 61000-4-4	± 2 kV for power supply lines ±1 kV for input / output lines	± 2 kV for power supply lines ±1 kV for input / output lines	Mains power should be that of a typical commercial or hospital environment.
Surge EN 61000-4-5	± 1 kV differential mode ± 2 kV common mode	± 1 kV differential mode ± 2 kV common mode	Mains power should be that of a typical commercial or hospital environment.

Voltage dips, short interruptions and voltage variations on power supply input lines EN 61000-4-11	<p><5% U_t (>95% dip in U_t) for ½ cycles</p> <p>40% U_t (60% dip in U_t) for 5 cycles</p> <p>70% U_t (30% dip in U_t) for 25 cycles</p> <p><5% U_t (>95% dip in U_t) for 5 s</p>	<p><5% U_t (>95% dip in U_t) for ½ cycles</p> <p>40% U_t (60% dip in U_t) for 5 cycles</p> <p>70% U_t (30% dip in U_t) for 25 cycles</p> <p><5% U_t (>95% dip in U_t) for 5 s</p>	Mains power should be that of a typical commercial or hospital environment. If the user of the Lode ergometer requires continued operation during power mains interruptions, it is recommended that the Lode equipment be powered from an uninterruptible power supply or a battery.
Power frequency (50/60 Hz) magnetic field EN 61000-4-8	3 A/m	3 A/m	Power frequency magnetic fields should be at levels characteristics of a typical location in a typical commercial or hospital environment.

NOTE: U_t is the AC mains voltage prior to application of the test level.

The Lode equipment is intended for use in the electromagnetic environment specified below. It is the responsibility of the customer or user to ensure that the Lode equipment is used in such an environment.

Immunity Test	IEC 60601-Test Level	Compliance Level	Electromagnetic Environment - Guidance
Conducted RF 61000-4-6	3 Vrms 150 kHz to 80 MHz	3 Vrms	<p>Portable and mobile RF communications equipment should be used no closer to any part of the Lode equipment including cables, than the recommended separation distance calculated from the equation applicable to the frequency of the transmitter.</p> <p>Recommended separation distance: $d = 1,2 \sqrt{P}$</p>
Radiated RF 61000-4-3	3 V/m 80 MHz to 2,5 GHz	3 V/m	<p>$d = 1,2 \sqrt{P}$ 80 MHz to 800 MHz $d = 2,3 \sqrt{P}$ 800 MHz to 2,5 GHz</p> <p>where P is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer and d is the recommended separation</p>

			<p>distance in meters (m).</p> <p>Field strengths from fixed RF transmitters, as determined by an electromagnetic site survey a , should be less than the compliance level in each frequency range.</p> <p>b</p> <p>Interference may occur in the vicinity of equipment marked with the following symbol:</p> 
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NOTE 1: At 80 MHz and 800 MHz, the higher frequency range applies.

NOTE 2: These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects, and people.

- a. Field strengths from fixed transmitters, such as base stations for radio (cellular/cordless) telephones and land mobile radio, amateur radio, AM and FM radio broadcast and TV broadcast cannot be predicted theoretically with accuracy. To assess the electromagnetic environment due to fixed RF transmitters, an electromagnetic site survey should be considered. If the measured field strength in the location in which the equipment is used exceeds the applicable RF compliance level above, the equipment should be observed to verify normal operation. If abnormal performance is observed, additional measures may be necessary, such as re-orienting or relocating the equipment.
- b. Over the frequency range 150 KHz to 80 MHz, field strengths should be less than 3 V/m.

Recommended Separation Distances between Portable and Mobile RF Communication Equipment and the Lode equipment	
<p>TheLode equipment is intended for use in the electromagnetic environment on which radiated RF disturbances are controlled. The customer or the user of theLode equipment can help prevent electromagnetic interference by maintaining a minimum distance between portable and mobile RF communications equipment (transmitters) and the Lode equipment as recommended below, according to the maximum output power of the communications equipment.</p>	
Rated maximum output Power	Separation Distance in Meters (m) according to frequency of Transmitter

Transmitter in Watts W	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	0,37	0,37	0,74
1	1,17	1,17	2,33
10	3,7	3,7	7,37
100	11,7	11,7	23,3

For transmitters rated at a maximum output power not listed above, the recommended separation distance [d] in meters (m) can be estimated using the equation applicable to the frequency of the transmitter, where **P** is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer.

NOTE:

These guidelines may not apply in all instances. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.