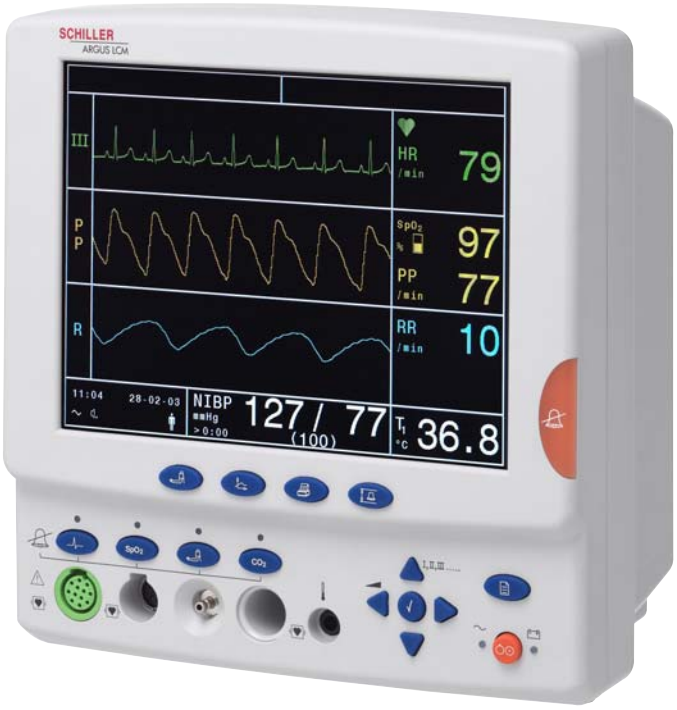
ARGUS LCM

Patient monitor
ARGUS LCM and ARGUS LCM PLUS



Service Handbook

SCHILLER

The Art of Diagnostics

Art. no.: 2.540033 rev.: d

Sales and Service Information

The SCHILLER sales and service centre network is world-wide. For the address of your local distributor, contact your nearest SCHILLER subsidiary. In case of difficulty a complete list of all distributors and subsidiaries is provided on our internet site: http://www.schiller.ch.

Sales information can also be obtained from:
sales@schiller.ch

Address Headquarters

SCHILLER AG
Altgasse 68
CH-6341 Baar, Switzerland
Web: www.schiller.ch

Phone: +41 (0) 41 766 42 42
Fax: +41 (0) 41 761 08 80,
E-mail: sales@schiller.ch

Article no.: 2.540033 rev.: d
Issue date: 27.03.08

SCHILLER
The Art of Diagnostics

Contents

Art. no.: 2.540033 rev.: d

Art. no.: 2.540033 rev.: d

Art. no.: 2.540033 rev.: d

Art. no.: 2.540033 rev.: d

Art. no.: 2.540033 rev.: d

Art. no.: 2.540033 rev.: d

1 Safety notes

This Service Handbook is for qualified service personnel only, trained by Schiller AG. Refer to the operating instruction manual 2.510474 for operation the device.

1.1 Responsibility of the user

- ▲ Specify the competencies of the personnel for operation and repair.
- ▲ Ensure that service personnel have read and understood these service instructions. In particular this section “safety notes" must be read and understood.
- ▲ Have damaged or missing components replaced immediately.
- ▲ The service personnel is responsible for compliance with all applicable accident prevention regulations and safety regulations.

1.2 Intended use

- ▲ The ARGUS LCM/PLUS is a patient monitoring device used for the measuring of the parameters of a patient, including ECG, SpO_2, CO_2 non and invasive blood pressure, temperature and respiration.
- ▲ Only operate the device in accordance with the specified technical data.
- ▲ Do **not** use or repair this unit in areas where there is any danger of explosion or in the presence of flammable gases such as anaesthetic agents.

1.3 Organisational measures

- ▲ Before servicing the unit, ensure that an introduction regarding the unit functions and the safety precautions has been provided by Schiller AG
- ▲ Keep these service instructions in an accessible place for reference when required. Make sure that they are always complete and legible.
- ▲ Observe the operating instructions and service instructions.
- ▲ These service instructions do not override any statutory or local regulations, or procedures for the prevention of accidents and environmental protection.

1.4 Safety-conscious operation

- ▲ Do not place any liquids on the unit. If liquid should be spilled over the device, immediately disconnect the device from the mains and wipe it. The device must be serviced before reusing.
- ▲ Danger of electric shock! Do not open the device without disconnecting the device from the mains.
- ▲ Before cleaning and to isolate the mains power supply, switch the unit off and disconnect it from the mains by removing the plug.
- ▲ Do not use high temperature sterilisation processes (such as autoclaving). Do not use E-beam or gamma radiation sterilisation.
- ▲ Do not use solvent or abrasive cleaners on either the unit or cable assemblies.
- ▲ Do not, under any circumstances, immerse the unit or cable assemblies in liquid.

Art. no.: 2.540033 rev.: d

1.5 Safety facilities

▲ Operating the device without the correctly rated fuse, or with defective cables, constitutes a danger to life. Therefore:

- Do not operate the unit if the earth connection is suspect or if the mains lead is damaged or suspected of being damaged.
- Damaged cable connections and connectors must be replaced immediately.
- The electrical safety devices, such as fuses, must not be altered.
- Ruptured fuses must only be replaced with the same type and rating as the original.

1.6 Operation with other devices

▲ Use only accessories and other parts recommended or supplied by SCHILLER AG. Use of other than recommended or supplied parts may result in injury, inaccurate information and/or damage to the unit.

▲ Ancillary equipment connected to the analogue and/or digital interfaces must be certified according to the respective IEC standards (e.g. IEC/EN 60950 for data processing equipment and IEC/EN 60601-1 for medical equipment). Furthermore all configurations shall comply with the valid version of the system standard IEC/EN 60601-1-1. Everybody who connects additional equipment to the signal input part or signal output part configures a medical system, and is therefore responsible that the system complies with the requirements of the valid version of the system standard IEC/EN 60601-1-1. If in doubt, consult the technical service department or your local representative.

- EC/EN 60601-1-1 states that the patient must remain at least 1.5 meters clear of the unit. If this is not possible, a safety isolating transformer must be installed.

▲ Medical electrical equipment is subject in regard to the electromagnetic compatibility (EMC) and its special precautionary measure. (see chapter 12.4 page 131)

▲ Portable and mobile Radio Frequency (RF) – communicating systems (such as cell phones) can have influence to medical electrical equipment.

Art. no.: 2.540033 rev.: d

1.7 Safety Symbols and Pictograms

1.7.1 Used symbols in this document

The safety level is classified according ANSI Z535.4. The following overview shows the used safety symbols and pictograms used in this manual.

For a direct danger which could lead to severe personal injury or to death.

For a possibly dangerous situation, which could lead to heavy bodily injury or to death.

For a possibly dangerous situation which could lead to personal injury. This symbol is also used to indicate possible damage to property.

For general safety notes as listed in this chapter.

Used for electrical dangers, warnings and other notes in regarding operation with electricity.

Note For possibly dangerous situations, which could lead to damages to property or system failure. **Important** or helpful user information

Reference to other guidelines

Observe precautions for handling electrostatic sensitive devices.

Used tool for the following procedure.

Interference may occur in the vicinity of equipment marked with following Symbol “non ionizing radiation” (see chapter 12.4 page 131)

Art. no.: 2.540033 rev.: d

1.7.2 Used symbols on the device

Potential equalization

CF symbol. This unit is classified safe for internal and external use. However, It is only defibrillation protected when used with the original SCHILLER patient cable!

Inappropriate disposal can lead to environmental pollution.

Units/components and Accessoires no longer required can be returned to SCHILLER AG for disposal. Alternatively, the unit should be disposed of in a municipally approved recycling centre.

CE 0123

Notified body of the CE certification (TÜV P.S.)

Attention: Consult accompanying documents.

Art. no.: 2.540033 rev.: d

2 Introduction

Following an overview of the different version of the ARGUS LCM/PLUS (**L**ow Weight and **C**ompact **M**onitor)

2.1 Version overview / compatibility

2.1.1 ARGUS LCM (basic) from serial number 781.000-781.999

The following table shows the equipment of the ARGUS LCM. This basic device cannot be upgraded.

ARGUS LCM	ECG	SpO_2	NIBP	Microprocessor	Connector board
Basic device	Only with 3 leads/display one lead (II)	x	x	MK19-10	MK19-50
Options: printer, additional battery (can be updated in the field)					

2.1.2 ARGUS LCM (basic) from serial number 781.1000-xxxx

The microprocessor board MK19-11 is populated with a monitoring ECG amplifier. This supports 2 cables. 3p-lead cable (RA, LA, LL and measures 6 derivations) and 5-lead cables. This works only with software 1.24 and higher.

ARGUS LCM	[a]ECG	SpO_2	NIBP	Respiration	Temp.	$etCO_2$	IBP	Microprocessor board	Connector board
A	x	x	x	x	1x			MK19-11	MK19-5
B	x	x	x	x	1x	x		MK19-11	MK19-5
D	x	x	x	x	1x		x	MK19-11	MK19-53
E	x	x	x	x		x	x	MK19-11	MK19-54

[a] Monitoring amplifier only with 3p- and 5 lead cable (6 or 7 lead display).➡ Modus-x possible.

- Options for all versions: printer, additional battery and nurse call or vehicle power supply.
- Version A can be upgraded with $etCO_2$ module, printer and additional battery.

2.1.3 ARGUS LCM PLUS from serial number 780.001-xxxx

ARGUS LCM PLUS Version	[a]ECG	SpO_2	NIBP	Respiration	Temp	$etCO_2$	IBP	Microprocessor board	Connector board
A	x	x	x	x	1x			MK19-1	MK19-5
B	x	x	x	x	1x	x		MK19-1	MK19-5
D	x	x	x	x	1x		x	MK19-1	MK19-53
E	x	x	x	x		x	x	MK19-1	MK19-54

[a] Only with 3- or 5- or 10 lead cable (1- or 7- or 12 lead display).

- Options for all versions: printer, additional battery and nurse call or vehicle power supply.
- Version A can be upgraded with $etCO_2$ module, printer and additional battery.

Art. no.: 2.540033 rev.: d

2.1.4 Nurse call option version 1

The version 1 is prepared only for a relays contact NO.

Board number	Board type	LCM version	Index
3.2561	MK19-5	Basic/LCMplus version A and B	A
3.2564	MK19-50	Basic	A

2.1.5 Nurse call option version 2

Following boards indexes are prepared with potential free change over contact relays NO/NC.

Board number	Board type	LCM version	Index
3.2561	MK19-5	Basic/LCMplus version A and B	C
3.2564	MK19-50	Basic	B
3.2566	MK19-53	Basic/LCMplus version D	A
3.2567	MK19-54	Basic/LCMplus version E	A

Nurse call cable version 2 p/n 3.920908.

With the same boards index changes Masimo MS-7 to MS-3 board.

2.1.6 SpO2 sensors Masimo and Nellcor MP-100

The LCM can be equipped with Masimo or Nellcor SpO2 sensors. The type of used sensor is applied on the front of the LCM housing. If LCM will be upgraded, the type of used sensor must be labelled on the front of the LCM housing.

Nellcor module

Following board indexes are prepared to equip with Nellcor module

Board number	Board type	LCM version	Index
3.2561	MK19-5	Basic/LCMplus version A and B	C
3.2564	MK19-50	Basic	B
3.2566	MK19-53	Basic/LCMplus version D	B
3.2567	MK19-54	Basic/LCMplus version E	B

2.1.7 LCD display replacing version 1 to 2

The LCD version 1 (Samsung 16 pin) have been replaced by LCD version 2 (AU Optronics 20 pin). The table below shows the board compatibility for LCD version 2.

Board number	Board type	LCM version	Index
3.2574	MK19-11	Basic > xxx.1000 Board prepared but 20 pin connector not soldered in.	AA
3.2574	MK19-11	Basic > xxx.2000 Board ready with 20 pin connector	BB

Art. no.: 2.540033 rev.: d

Board number	Board type	LCM version	Index
3.2563	MK19-10	Only 14 pin connector. Only LCD version 1 can be used	E
3.2560	MK-19-1	Only 14 pin connector. Only LCD version 1 can be used	E
3.2560	MK-19-1	20 pin connector. Only LCD version 2 can be used. Requires new housing.	FC

Board 19-11 with index FA has the 20 pin connector at the backside.

Board 19-10 and 19-1 index F has only 14 pin LCD connection, so only LCD version 1 can be used.

To replace a defective LCD version 1 with the LCD version 2 a new front housing is needed. See following table where a front is needed.

Housing V2 = Sticker for SpO_2 module + Schiller = LCD version 2

LCM Type	Serial number	LCD Type	Front required
LCM Basic	781.0000 - 781.01716	Samsung	Yes
LCM Basic	781.02000-xxxxx	AU Optronics	No
LCM plus	780.0000 - 780.03183	Samsung	Yes
LCM plus	780.03184-780.xxxxx	AU Optronics	No

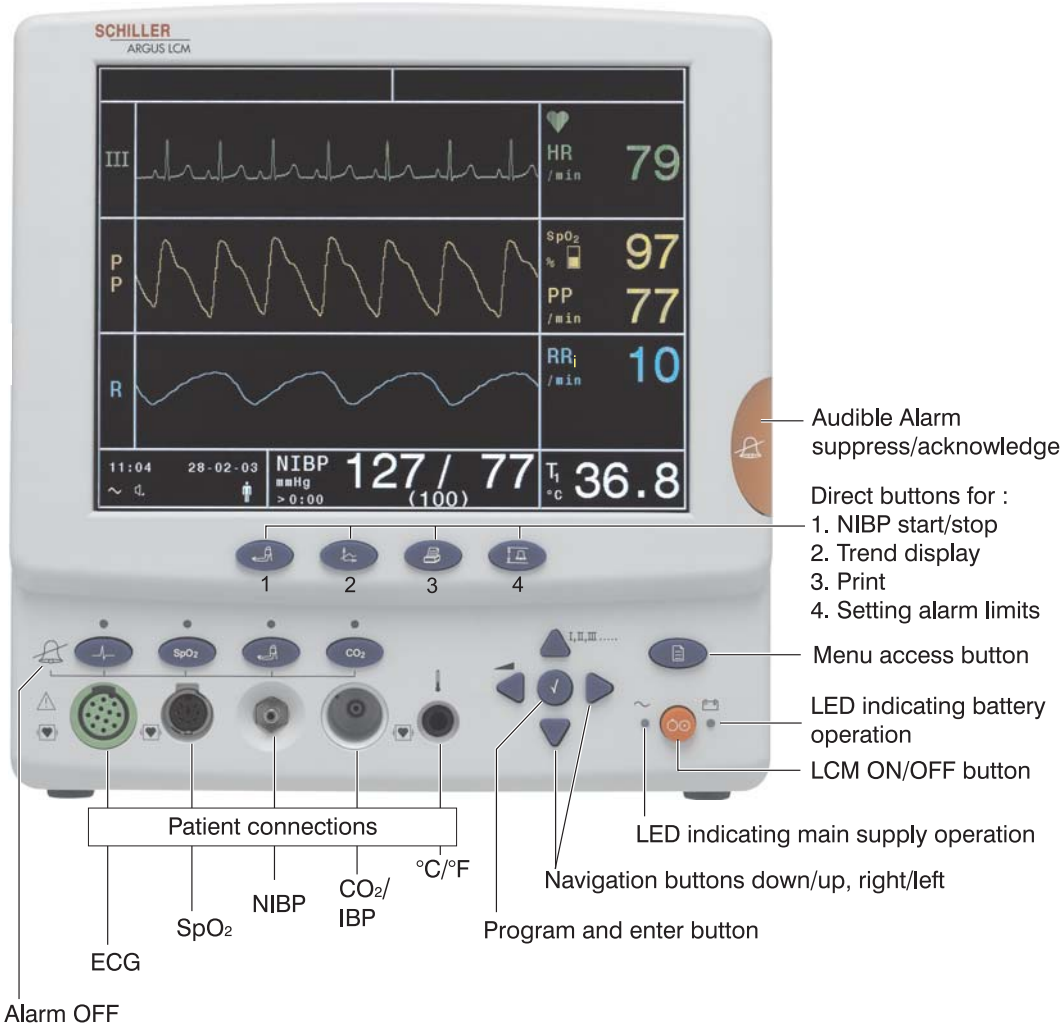
2.1.8 NIBP pump versions

ARGUS LCM plus / basic	V1 • 1300 ccm • 4.330040	V2 • 1300 ccm • 3.920921	V3 • 2300 ccm • 4.330044	201R Current limit 1 A	301R Current limit 1.3 A
780 / 781.xxx - 2999	**x**			x	
780 / 781.xxx - 2999		**x**		x	optional preferred
780 / 781.3000- xxxx			**x**		x
Board/ Index					
MK-1/EV					x
MK-10/AF					x
MK-11/BE					x

Art. no.: 2.540033 rev.: d

2.2 Functional overview

2.2.1 Buttons of the ARGUS LCM PLUS



Access to the menu IBP and NIBP alarm on/off and IBP calibration.

This is the LCM plus version E.

IBP connection instead of Temperature

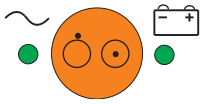
This is the LCM plus version D.

IBP connection instead of CO_2

Fig. 2.1 ARGUS LCM front view

Art. no.: 2.540033 rev.: d

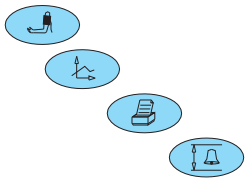
2.2.2 Description of buttons



ON/OFF
The LED indicates if the LCM is running from mains power or battery.

Button for suppression/acknowledgement of audible alarms
The alarm can be suppressed or acknowledged in two ways. This is defined in settings **About+/Alarm setup menu**.

See detailed description in paragraph 3.6.2



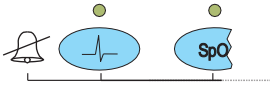
Direct buttons for:

(1) NIBP start/stop or, if pressed for 2 s, switch between auto and manual

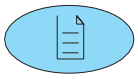
(2) Trend and alarm displays

(3) Printout of the current display

(4) Alarm limit settings



Alarm off
These buttons disable alarms of the individual parameters. Acknowledgement is displayed on the top left e.g. **ECG Alarm OFF**. The LED above the corresponding button is lit (for details refer to section 3.6.3).

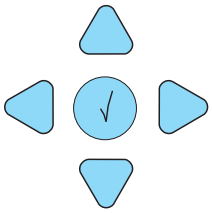


Menu access

Opens the main menu. Navigate through the menus with the **right/left** buttons. Press the menu button to again leave the menu.

Enter

Navigation



The navigation and enter buttons have different functions dependent on operating mode:

Normal single lead display:
Pressing the enter button shows the first 3 leads instead of the single lead display.

By pressing the **up/down** buttons, the next lead, or lead group is displayed.

Press the **left** button to adjust the loudness of the audible alarm and the QRS signal.

Programming mode:

1. Activating the programming mode with the **menu** button.
2. Selecting the menu with the **left/right** buttons.
3. Selecting a value with the **up/down** buttons.
4. Press the **enter** button.
5. Change a value using the **up/down** buttons.
6. Retrieve a value by pressing **enter**.

Trend display mode:
Activate the trend display mode with the **trend display** button.
Use the
left/right buttons to move forward/backward in the trend display.
Use the **trend** button to toggle between the trend display, alarm display and normal monitor display.

Art. no.: 2.540033 rev.: d

2.2.3 Description of display

Alarms

(1) Status field for physiological alarms
(2) Status field for technical alarms

Curve field

(3) 1 or 3 channel lead display. With **enter** display 1 or 3 leads, with **up/down** select the following/previous lead/lead group.

System status field

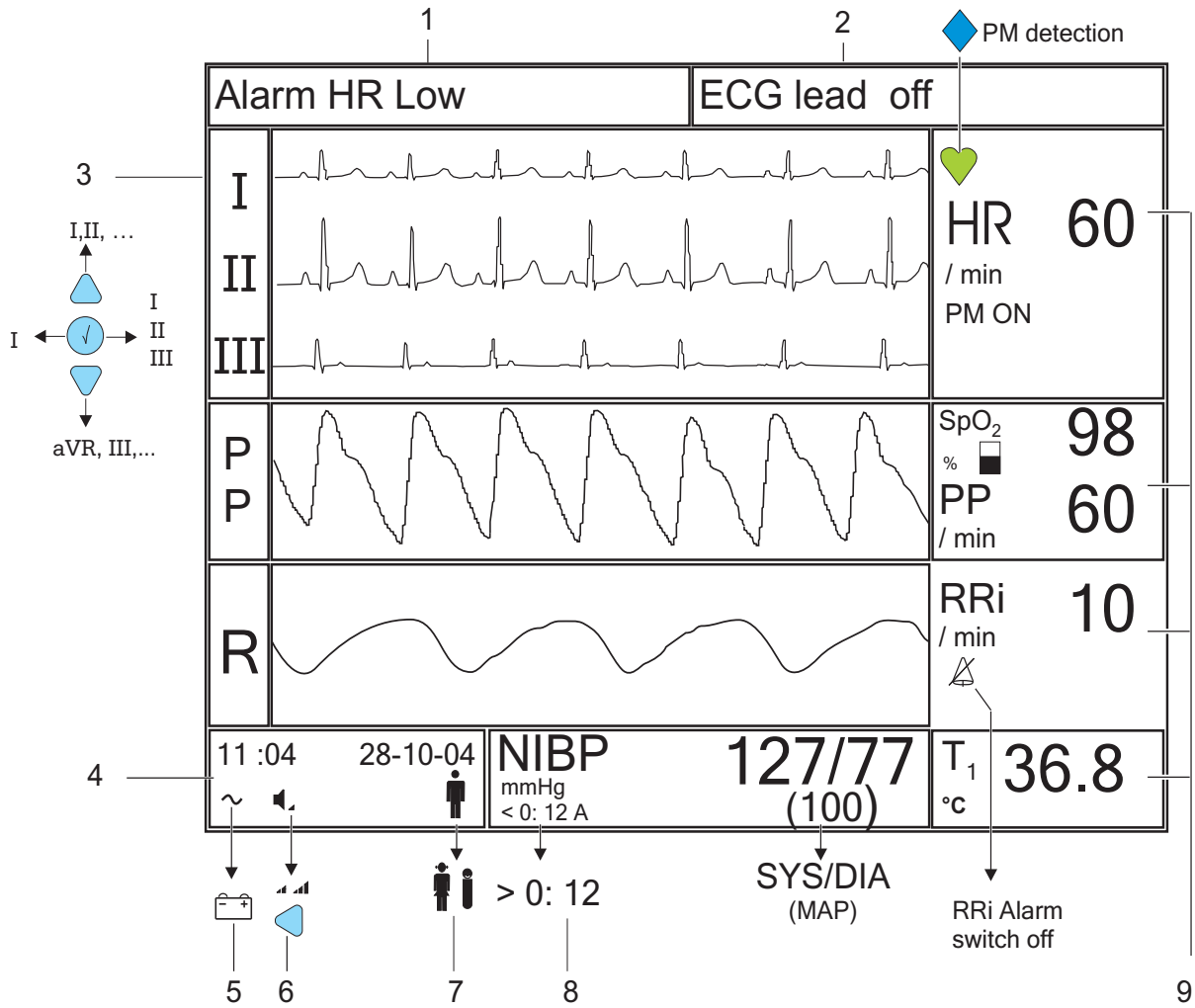
(4) System status field
(5) Symbol for battery operation.
(6) Loudness (3-step) for alarm- and QRS-sound. Adjust with **left** button.
(7) Symbol of the selected patient type.

Blood pressure

(8) **< 0:12 A** = remaining time (h/min) to the next automatic blood pressure measurement.
> 0:12 = Time since the last manual blood pressure measurement
Remark: During blood pressure measuring the current system pressure in mmHg is displayed.

Measurement field

(9) Various displayed values e.g. HR, $Sp0_2$, IBP, CO_2, RRi, temperature.



Art. no.: 2.540033 rev.: d

2.2.4 Navigation and changing values in the menu

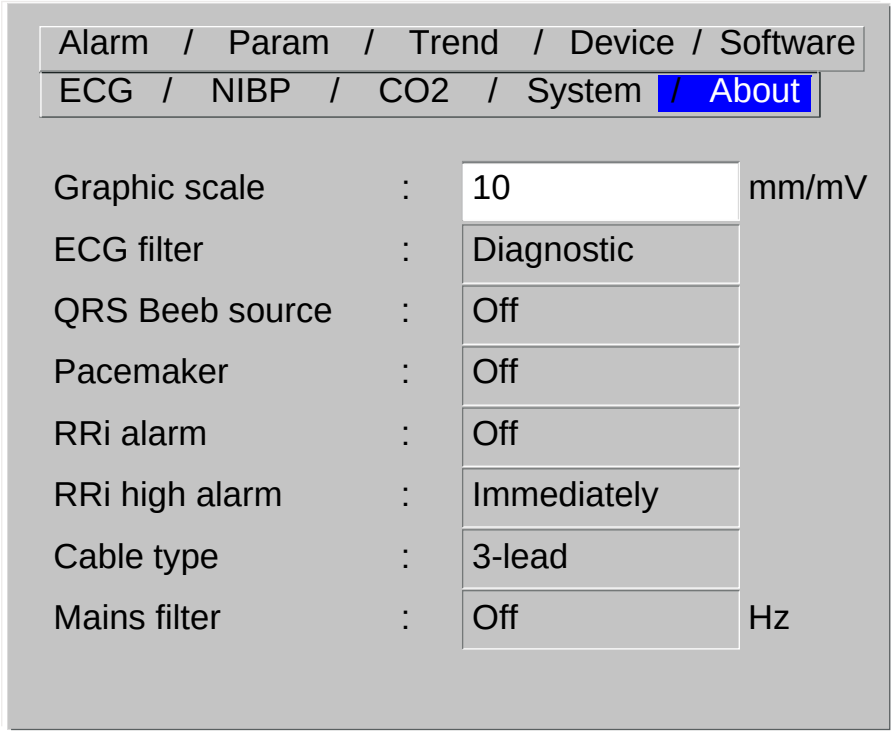


Fig. 2.2 Picture menu

The upper menu display is normally hidden. The extended menu display can be displayed with the following combination of buttons.

Press , select menu **About** press, and then .

Top change values proceed as follows:

Select with the desired parameter (white box) and press to get access and change or selecting value with and confirm with .

The changed value will be not permanently stored. After power off/on the default value will be set. To store changed value as default permanently refer to chapter 3.3.2

3 Operation

3.1 Start-up

DANGER

▲ Danger of electrical shock. Do not operate the unit if the earth connection is suspect or if the mains lead is damaged or suspected of being damaged.

3.1.1 Connecting and power on

Potential equalisation Cable
p/n 2.310056

(1) RS-232
(2) Mains connection (115 or 230 VAC)
(3) Potential equalisation connection (Cable p/n 2.310056)
(4) Nurse call or DC in 11 - 30 VDC (option)

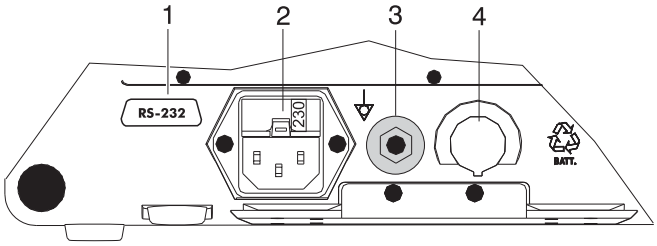


Fig. 3.1 ARGUS LCM back panel

1. Voltage setting (2) 115 or 230 V. Refer to chapter 4.2 for the mains voltage. Connect the power cable at the rear of the unit.
2. Connect the potential equalisation cable (3) and all other necessary cables at the rear of the LCM.
3. Press the **on/off** button.
4. Check that all LEDs flash shortly and there is a beep on start-up.
5. Check the settings according to chapters 3.3 and 10.1.

3.1.2 Boardnet supply

Only with board net supply option installed. (see picture (4) above.

4.260419

4.260400

Fig. 3.2 Boardnet plugs

1. See internal cable page 102.
2. Use one of the board net plugs
3. Use a stranded wire with 2.5 mm^2 or bigger depending in the cable length and other requirements.

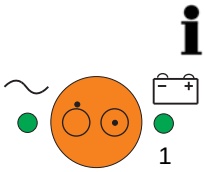
Boardnet Supply

11 ...30 VDC, I max. 2.5 A

Remarks: The boardnet connection is not certified to use in ambulance or air rescue.

Art. no.: 2.540033 rev.: d

3.1.3 Battery operation



Important

The Battery operation is indicated by the LED below the battery symbol.

When the battery charge is low, the alarm message **Battery low** appears and

- the LED (1) blinks
- the Battery symbol in the bottom left display field blinks

for Battery recharging refer to chapter 4.1

3.2 Switching off and disconnecting from mains

1. Press the **on/off** button. A dialogue window appears.
2. Select with the **left** button **YES** and confirm the selection with the **enter** button.
3. Remove the mains cable from the mains supply socket (2) (see Fig. 3.1) to isolate the device from the mains.

Important

If no dialogue window appears it is possible to switch off the device by keeping the **On/Off** button pressed for 10 seconds.

3.2.1 Interruption of the mains supply

If the mains supply is interrupted, the device automatically switches over to battery operation. The user settings are maintained. These settings can be saved in the menu About+**/Software**.

Art. no.: 2.540033 rev.: d

SCHILLER
ARGUS LCM/PLUS

3.3 Initial settings

This chapter details the most important and typical programming sequences.

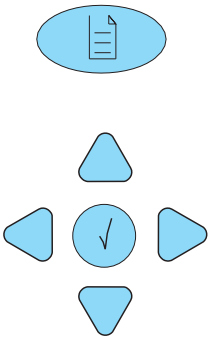
WARNING

▲ Only authorised personnel, trained in the operation of this device, are permitted to do the setups in the following menu.

The extended menu display **About+** can be displayed with the following combination of buttons.

Press , select menu **About** press, and then .

3.3.1 Selecting the language



1. Open the menu **About+** and select menu **Device**.
2. Confirm with the **enter** button.
3. Press the **down** button and select the language.
4. Confirm with the **enter** button.
5. Press **right/left** to move to the next menu and continue with more setups.
6. Save the user settings. Open the menu **Software**, select **Save as Default** and confirm with the **enter** button.
7. Return by pressing the **menu** button to the normal display mode.

For system settings see detailed list in the chapters 10.1.1and 10.1.2.

3.3.2 Save and restore default settings

Changed values can be stored permanently and again restored. See chapter 10.1.2.

1. Select the menu About+/Software.
2. Select **Save as Default** or **restore Defaults** and confirm with the Enter button. It will now save or restore the default settings.

3.3.3 Load factory defaults

The SCHILLER factory defaults are listed in chapter 10.2. When you load these defaults, they will over write the user settings and language changes to german default.

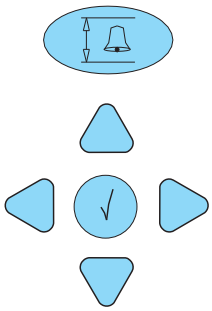
If selecting factory defaults the language changes to english default settings.

1. Open the menu **About** and select menu **Software**.
2. Select function **factory defaults** and confirm with the **enter** button. The factory defaults will be loaded.
3. Press the **menu** button to exit the programming mode.

Art. no.: 2.540033 rev.: d

3.3.4 Setting alarm limits

All alarm limits are reset to the default or user specific system settings after switching the unit off/on, if they have not been stored as default. (see menu **About+/Software**) There are no alarm limits for temperature.



1. Press **alarm limit** button.
2. Press **up/down** or **left/right** buttons to select an alarm parameter and confirm with **enter**. The entry field appears blue.
3. Press **up/down** to change the value and confirm with the **enter** button.
4. Press the **up/down** or **left/right** buttons to select other parameters or press the **alarm limit** button to exit the menu.

The following table gives the default alarm limits settings for adults. A changed value can be stored as default in the menu **About+/Software**.

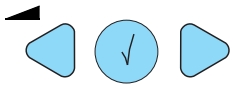
The factory defaults are listed in the sections 10.1 and 10.2.

Alarm	Low	High	Unit	[a]Prio.	[b]Print
HR	50	140	/min	High	Off
ASYS		2	s	High	Off
[c]RRi	8	35	min	Low	Off
[c]APNi		20	s	High	Off
SpO_2	90	101	%	Low	Off
PP	50	140	min	High	Off
SYS	100	140	mmHg	Low	Off
DIA	40	95	mmHg	Low	Off
MAP	70	140	mmHg	Low	Off
Ps	95	50	mmHg	low	Off
Pm	50	100	mmHg	low	Off
Ps	40	100	mmHg	low	Off
eCO_2	35.0	45.0	mmHg	Low	Off
CO_2 i	0.0	1.5	mmHg	Low	Off
RRc	8	25	/min	low	Off
APNc		25	s	low	Off

a. "High" priority = audible signal with 2 x 5 impulses.
"Low" priority = audible signal with 1 x 2 impulses and 20 s pauses between the impulse sequences.
b. Print "On" = Default printout containing a warning message when the min./max. value is exceeded.
c. If the RRi alarm option is **Off** in the **ECG** settings panel, the "Low" and "High" values for RRi and APNi will be "Off".

Art. no.: 2.540033 rev.: d

3.3.5 Setting loudness of audible alarm and QRS sound



1. Select normal monitor mode. Press **menu** if in programming mode or **trend** if in trend display.
2. Press the **left** button to adjust the loudness. The pictogram in the status display on the bottom left shows the current setting.

Art. no.: 2.540033 rev.: d

3.4 Trend or alarm display

The trend values are stored for all parameters every minute and additionally on every manual NIBP measurement over the last 24 hours. The trends can be displayed in graphical or tabular.

The display interval for the table can be selected in the menu **About+/Trend**. The displayed trend table or not acknowledged alarms can be printed out by pressing the **print** button. The displayed graph cannot be printed.

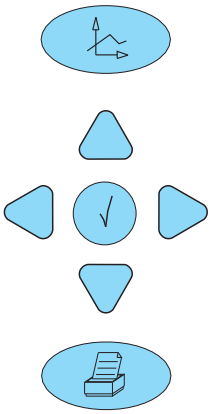


Table display

1. Press the **trend** button. The trend will be displayed in a table in 1, 5,15, 30, 60, 120 or 240 minute intervals. Change the displayed interval using the **up/down** button. Move the display forward/backward on the time axis using the **left/right b**utton.

Graph display (cannot be printed**)**

2. To display the graph, press the **trend** button once again. The graph's time frame corresponds to 3 hours. Display the next 3 h by pressing the **up/down** button. Move the cursor on the top right corner using the **right/left** button to display the exact measured values for the selected position on the right. The cursor can be positioned on the NIBP value by pressing **ENTER**.

Display of not acknowledged alarms

3. To display the last 12 not acknowledged alarms, press the **trend** button a third time.

3.5 Display of additional leads

The LCM basic serial number 0-999 can only measure lead II.

1. Select the normal monitor mode. Press **menu** if in programming mode or **trend** if in trend display.
2. Press the **enter** button to switch between the normal display mode containing one lead and the 3-lead display.
3. By pressing the **up/down** buttons, the next leads are displayed.

Art. no.: 2.540033 rev.: d

3.6 Procedure in case of an alarm

3.6.1 Display of alarms

During initial switching on

The alarms are suppressed for a defined time (programmable in the menu **About+/ Alarm.** Alarm suppr. time standard is 3 minutes)

The message **Alarm suppressed 3:00** appears.

During monitoring

There are two alarms:

- Technical alarm, displayed in the alarm status field on the top right.
  In case of a technical alarm, an audible alarm sounds and the measurement field for the respective value flashes.
- Physiological alarms, displayed in the alarm status field on the top left.
  In the case of a physiological alarm, an acoustic alarm sounds and the measurement field for the respective value flashes.

3.6.2 Suppressing/acknowledging an audible alarm

There are two ways to proceed in the case of an alarm. The procedure depends on the set alarm stop mode **(On/Off)** and the **alarm suppression time in the menu About+/Alarm**:

(1) Alarm stop off (suppression)

This function suppresses an audible alarm for a defined period of time (2..10 min.). However, the flashing measurement field (red measured value and coloured field) will remain. The audible alarm is reactivated after the defined period of time has elapsed.

(2) Alarm stop on (acknowledging)

This function will suppress an audible alarm as long as the defined alarm limits are exceeded. However, the flashing measurement field (red measured value and coloured field) remains.

3.6.3 Preventive alarm suppression

The preventive alarm suppression is used to deactivate in advance all alarms that may be caused by disconnecting patient cables, loose electrodes and relocation of the patient.

➜ Press the **alarm** button and confirm with the **enter** button before an alarm is displayed.

Message **Alarm suppressed 3:00** is displayed. The time can be programmed in the menu **About+/Alarm/Alarm suppr. time**.

As soon as the time has expired, the acoustic and the visual alarms are again reactivated.

Removing of the patient cables

If a cable is removed the message **Cable off or no Sensor** is displayed.

➜ Press the button **alarm suppressing**.

The alarm is deleted and the measured value field is no longer indicated.

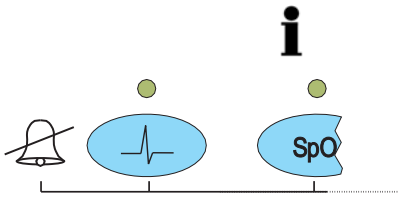
Art. no.: 2.540033 rev.: d

3.6.4 Switching off an alarm

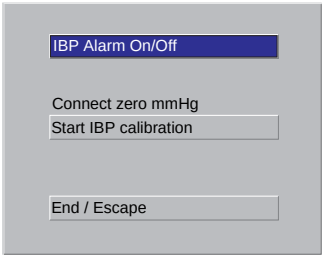
Each alarm off function is password protected. Read carefully the following warning and information:

WARNING

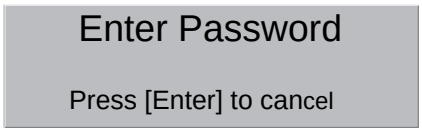
▲ When the acoustic alarm is switched off, the patient acoustic physiological alarms are silenced and suppressed indefinitely. Use this function only if disconnecting a sensor from the patient for a long period of time.



- When the **alarm off** button is pressed, the audible alarm for the respective parameter is suppressed. This is indicated by the LED above the button and a message on the monitor, e.g. **Alarm ECG OFF**. If an alarm occurs as long as the **alarm off** button is pressed, a visual alarm is displayed in the respective measurement field.
- With the LCM plus version E the access to the IBP alarm off function will be executed by the NIBP alarm button. A menu with blood pressure alarm off (common for NIBP and IBP) and IBP calibration function appears.



Entering alarm OFF password



1. Press the desired alarm off button. The password dialog appears.
2. Press following button to enter the password:

1. The password protection can be disabled in the special menu see chapter 4.1.2 page 29

Art. no.: 2.540033 rev.: d

3.6.5 Overview of physiological alarms

Alarm abbreviation	Description
Asys limit	Asystole time limit exceeded
SpO_2 Low/High	Oxygen saturation of the blood
PP Low/High	Peripheral pulse of SpO_2
RRi Low/High	Respiration rate impedance (from ECG electrode)
Apnea limit	Apnea time limit exceeded
CO_{2i} low/high	Inspiratory CO_2
RRc low/high	Capnographic respiration rate
eCO_2 low/high	End-tidal expiratory CO_2
SYS low/high	Systolic pressure
DIA low/high	Diastolic pressure
MAD low/high	Mean atrial pressure
HR low/high	Heart rate
Ps low/high	Invasive systolic blood pressure
Pm low/high	Invasive mean blood pressure
Pd low/high	Invasive diastolic blood pressure
Temp low/high	When the temperature is outside the measuring range, this is indicated by “<<“(below 15 °C) or “>>” (above 45 °C). This limit is fixed.

Art. no.: 2.540033 rev.: d

3.7 General Cleaning instructions

3.7.1 Cuff cleaning

CAUTION

- ▲ Do not use Chlorine
- ▲ Do not autoclave
- ▲ Follow the manufacturer's instruction. (Disinfectants and Cuff)

- If using machine washing, be sure that the hook and loop fastener are engaged
- The fastener can melt at temperature above 325° F / 162° C, when being ironed.
- Use 70% isopropyl alcohol or mild detergent for cleaning.

1. Remove the rubber inflation bag from the cuff.
2. Disinfect cuff and inflation bag if necessary or wash the cuff in warm, soapy water.
3. Rinse thoroughly to remove any residual disinfectants because of skin irritation.

3.7.2 SpO_2 Sensor

CAUTION

- ▲ Do not use undiluted bleach (5...5.25 % sodium hypochlorite)
- ▲ Do soak or immerse the cable or the sensor in any liquid solution
- ▲ Do not autoclave
- ▲ Follow the manufacturer's instruction. (Disinfectants and Sensor)

- Use 70% isopropyl alcohol or mild detergent for cleaning.

1. Disconnect sensor from the device.
2. Disinfect sensor and cable by wiping it with a 70% isopropyl alcohol pad.
3. Allow the sensor to dry prior to placement on a patient.

3.7.3 ECG cable

CAUTION

- ▲ Do soak or immerse the cable in any liquid solution
- ▲ Do not autoclave
- ▲ Follow the manufacturer's instruction. (Disinfectants and Cable)

- Use 70% isopropyl alcohol or mild detergent for cleaning.

1. Disconnect cable from the device.
2. Disinfect cable and clip by wiping it with a 70% isopropyl alcohol pad.
3. Allow the cable to dry prior to placement on a patient.

Art. no.: 2.540033 rev.: d

4 Setup and Programming

4.1 Settings menu

4.1.1 Main menu

Bold marked values are factory settings.

Main menu	Parameter	Values
ECG	Display sensitivity	5/**10**/20/40 mm/mV
	[a]ECG - Filter	**Diagnostic/** Monitoring 1 / Monitoring 2 / Artefact
	QRS beep source	**Off**/ ECG/ SpO_2
	Pacemaker	**Off** /On (If pacemaker on, it is no RRi measuring possible)
	RRi Alarm	**On** /Off
	Cable type	Display of the connected cable type (3p-,/3-/5-/10-lead)
	Mains filter	**Off**/ 50 or 60 Hz
NIBP	Initial pressure	Adult 180, pediatric 150, neonatal 120 mmHg (0..300)
	Autom. measuring	**Off/** On
	Interval time	2/3/5/10/15/ **30**/60 min
	Deflation speed	**5** (3..9) mmHg
	SpO_2 suppression	Off/ **On**
IBP	Scale	0..**300**/200/100/50/30/Auto
	Start IBP Calibration	Function
CO_2	Flow Rate	**200**/120/90 ml/min (see details page 31)
	O_2-Compensation	**Off/** On (Off = $O_2 \leq$ 60% / On = $O_2 >$ 60%)
	N_2O Compensation	**Off/** On (Off = 0% N_2O /On = ≥ 12%)
	Desflurane compensation	**Off/** On (On = Desflurane ≥ 12%)
	Steam compensation	**Off/** On
	BTPS compensation	**Off/** On
	Zero point cal. date	ddmmjj
	Two point cal. date	ddmmjj
	Start zero Point Calibration	Function
	Start two-Point Calibration	Function
System	Patient	**Adult/**Pediatric/Neonatal
	Date	ddmmjj
	Time	hhmm
About	Device info	see section 7.7.2

a. Diagnostic (Hardware, filtering low):High/low-pass: hp = 0.05 Hz, lp = 150 Hz for LCMplus and LCMbasic SN < 1000
Monitoring 1 (Hardware, filtering low):High/low-pass: hp = 0.5 Hz, lp = 40 Hz for LCMbasic SN > 1000
Monitoring 2 (Hard & Software, filtering medium):Hardware see above, SW_{hp} = 0.6 Hz, SW_{lp} = 35 Hz
Artefact (Hard- and Software, filtering high):Hardware see above, SW_{hp} = 2.4 Hz, SW_{lp} = 20 Hz

Art. no.: 2.540033 rev.: d

4.1.2 Special menu “About+”

WARNING

▲ Only authorised personnel which is trained in the operation of this device is allowed to do the setups of the following menu.

The extended menu display **About+** can be displayed with the following combination of buttons.

Press , select menu **About,** press and then

Main menu extended	Parameter	Value
About+		
Alarm	Alarm stop mode	On/**Off**
	Alarm suppr. time	**2** min (2 ... 10)
	Alarm sound	**DIN EN 475**/Standard
	Nurse call	**Immediately/**in 5 sec.
	Alarm restriction (see page 25)	**On/**Off
Param	Lead	**II**
	Lead speed	12.5/**25**/50 mm/s
	Respiration source	[a]**ECG**/CO_2
	Respiration speed	**6.25**/12.5 mm/s
	SpO_2 Pulse	4/**8** or 16 s
	SpO_2 sensitivity	**Low** /High
	NIBP adult Initial	**180**
	NIBP pediatric Initial.	**150**
	NIBP neonatal Initial	**120**
	NIBP MAP	**On**
	Temperature unit	**°C** /°F
	CO_2	**mmHg**/kPA/Vol%
Trend	View time	5, 15, **30,** 60, 120, 240 min
Device	Language	**English**/Deutsch/[b]Français/Svenska/American/Italiano/Español/Portuges/Norge
Software	Save as default	With this function, changed values can be permanently saved. (See section 3.3.2.)
	Restore defaults	With this function, the saved default values can be restored. (See section 3.3.2.)
	Factory Default	With this function, the factory default values can be restored.see section 3.3.3
	Service	see section 8.2
	Program update	see section 8.2

a. When the set respiration source is ECG and the pacemaker is on, respiration measurement via the ECG is not possible. The respiration wave field is not displayed in this case.
b. The Russian language requires a separate software.

Art. no.: 2.540033 rev.: d

SCHILLER
ARGUS LCM/PLUS

4.2 Factory settings

These values can be loaded from the menu About+/Software. See section 10.1.2.

Parameter	Abbrev.	Unit	Type	Limit	Step	Alarm Prio.	Adult	Child	Neonat
Heart rate	HR	min	High	80...220	5	Low	140	180	200
		min	Low	15...100	5		50	70	90
Asystole		s		2...20	1	High	2	2	2
Respiration	RR	min	High	25...120	5	Low	35	35	60
		min	Low	1...20	5		6	12	20
Apnea		s		15...45	1	Low	20	15	10
NIBP	SYS	mmHg	High	80...300	5	Low	180	180	80
		mmHg	Low	10...150	5		100	100	50
	DIA	mmHg	High	30...120	5	Low	95	95	45
		mmHg	Low	0...80	5		40	40	30
	MEAN	mmHg	High	0...200	5	Low	140	140	45
		mmHg	Low	0...100	5		70	70	30
	Pulse	min	High	80...220	5	Low	140	180	200
		min	Low	15...100	5		50	70	90
Pulsoximetry	SpO_2	%	High	80...101	1	High	101	101	98
		%	Low	70...99	1		90	89	88
	PP	min	High	80...220	5	Low	140	180	200
		min	Low	15...100	5		50	70	90
Capnography	eCO_2	Vol%	High	4.5...10	0.1	Low	6.0	6.0	6.0
		Vol%	Low	0...6.0	0.1		4.5	4.5	4.5
	CO_2i	Vol%	High	0.1...1.5	0.1	Low	0.2	0.2	0.2
		Vol%	Low	0...1	0.1		0	0	0
	eCO_2	kPa	High	4.5...10	0.1	Low	6.0	6.0	6.0
		kPa	Low	0..6.0	0.1		4.5	4.5	4.5
	CO_2i	kPa	High	0.1...1.5	0.1	Low	0.2	0.2	0.2
		kPa	Low	0...1	0.1		0	0	0
	eCO_2	mmHg	High	35.. 76.0	0.5	Low	45.0	45.0	45.0
		mmHg	Low	0. .45.0	0.5		35.0	35.0	35.0
	CO_2i	mmHg	High	1.. 10.0	0.5	Low	1.5	1.5	1.5
		mmHg	Low	0.. 8.0	0.5		0	0	0
IBP	Ps	mmHg	High	0...300	1	Low	180	180	180
		mmHg	Low	-20...150	1		95	95	95
	Pm	mmHg	High	0...200	1	Low	100	100	100
		mmHg	Low	-20...150	1		50	40	40
	Pd	mmHg	High	0...120	1	Low	100	100	100
		mmHg	Low	-20...80	1		40	40	40
T_1	T_1	°C or °F	No alarm	No settings	-	-	-	-	-

Art. no.: 2.540033 rev.: d

4.3 CO_2 settings

4.3.1 Description of CO_2 parameters

Parameter	Setup	Description
Flow rate	**200/**120/90 ml/min	To ensure that children and neonates have sufficient air to breathe, it is vital that the "System > Patient" ("Adult", "Pediatric", "Neonatal") and the CO_2 settings be checked. The flow rate for CO_2 measurement must be 120 ml/min for children and 90 ml/min for neonates.
O_2-Compensation	Off/On	**Correction factor for O_2 = 1.03** Additional oxygen O_2 in the CO_2 gas mixture reduces the IR absorption in the sensor. This leads to too low results when the CO_2 is measured. The correction is activated when the O_2 values are greater than 60%.
N_2O-Compensation	Off/On	**Correction factor for N_2O (laughing gas) = factor 0.952** Additional N_2O increases the IR absorption. However, N_2O does not influence the IR absorption directly but reduces the CO_2 molecule's absorption energy. The CO_2 molecule can therefore absorb more energy (IR radiation).
Desflurane Comp.	Off/On	**Correction factor for desflurane = 0.952, as for N_2O.** The compensation is activated when the desflurane concentration is greater than 12%. However, it has the same effect as N_2O compensation.
Steam Compensation	**On**/Off	Steam affects the IR absorption by CO_2 molecules. Its influence is calculated mathematically. The compensation is activated during normal side-stream measurement. During control loop measurement, e.g. CO_2 in the incubator, the compensation is deactivated.
BTPS compensation	**On**/Off	**B**ody **t**emperature, ambient **p**ressure, **s**aturated with steam. This factor compensates differences regarding humidity saturation in inspired and expired air. This compensation is used for side-stream measurement, as the device assumes 100% humidity and a temperature of 37 °C for expired air.

4.3.2 Compensation settings

O_2<-Compensation	N_2<O-Compensation	Desflurane Comp.	Condition
Off	Off	Off	O_2 less than 60%, no N_2 O or 25% N_2O and 75% O_2.
On	Off	Off	O_2 grater than 60%, no N_2O
Off	On	Off	N_2O greater than 12%
Off	Off	On	Desflurane greater than 12%
On	On	Off	O_2 greater than 60%, N_2O greater than 12%

Art. no.: 2.540033 rev.: d

4.3.3 Combination of N_2O and O_2 compensation

As the influence on N_2O is greater than on O_2, the influences can cancel each other out in a gas mixture of 25% N_2O and 75% O_2. In that case, both compensations can be deactivated. The overall correction when both compensations are active is 0.99.

4.3.4 Environmental pressure compensation

The environmental pressure is automatically compensated when the unit is switched on or the watertrap is connected.

4.3.5 Measuring principle Pryon LC110 CO_2 Module

Capnography

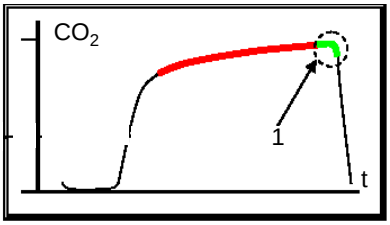


Fig. 4.1 Capnography

Capnography is the non-invasive measurement and graphic display of airway CO_2 concentration as a function of time. The resulting waveform is called capnogram. The evaluation of the capnogram is useful in the assessment of the carbon dioxide exchange in the lungs, the integrity of the patient's airways as well as the cardiopulmonary and ventilator functions.

(1) Monitoring of CO_2 concentration at the end of expiration is referred as end-tidal CO_2 (ETCO2) monitoring.

Measurement Calculation

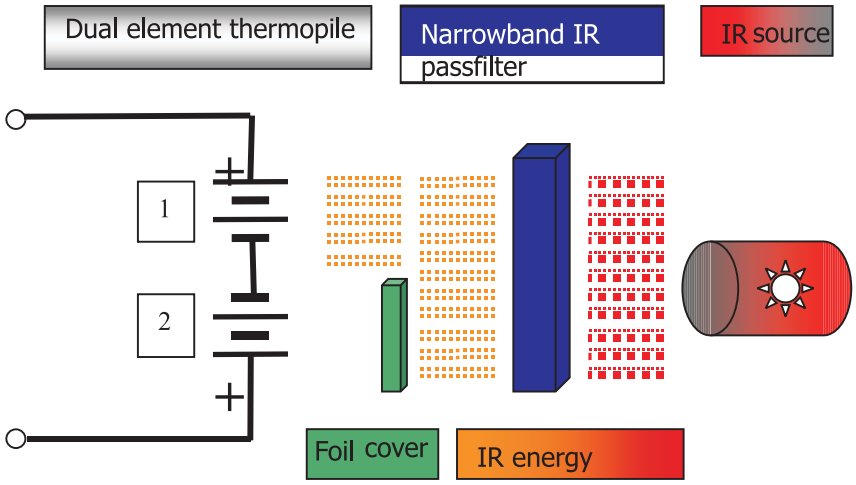


Fig. 4.2 Block diagram CO_2 measuring

The LC101 provides the following parameters

- ETCO2 (eCO2)
- Inspiratory CO2 (CO2i)
- Respiratory rate (RRC)

These three measurements are collectively referred to as breath data.

Art. no.: 2.540033 rev.: d

Measuring Principle CO_2

The CO_2 measurement is based on the infra-red (IR) absorption characteristics of CO_2 molecules. The CO_2 sensor uses non-dispersive IR spectroscopy to measure the number of CO2 molecules present in the sample gas. CO_2 gas has a unique absorption band which relates to a CO2 molecule's composition and mass. The CO_2 gas concentration is measured by detecting the absorption in this band. Due to the nature of the measurement technique employed, user calibration is necessary with this system.

The basic components of the CO_2 sensor (C-Cap bench) include

- IR source
- Dual element IR detector
- Optical filter
- Non-volatile memory

The **IR source** emits energy that is directed towards a dual element thermopile **IR detector.** The dual element design uses two opposing thermopiles connected in series. A change in the ambient temperature is compensated by the two elements so the output won't be distorted. Only one element is exposed to energy from the IR source, resulting in a voltage change due to only that energy. The detector generates a voltage based on the amount of energy it receives. The IR path between the IR source and the detector contains an **optical filter,** which only allows a specific IR wavelength to pass and the gas sample within the sensor chamber.

A temperature sensor is attached to the detector housing for temperature compensation beyond the thermopile's designed compensation, including temperature changes in the system sensitivity.

The detector generates a voltage in the mV range and an OP-amp on the circuit board amplifies the signal.

The **non-volatile memory** is an EPROM containing calibration and manufacturing data specific to the CO_2 sensor.

Measurement Compensation

The IR absorption in the CO_2 wavelength band may be affected by a number of factors that alter the CO_2 measurement. The LC101 module automatically compensates for some of these factors, while others must be set in the menu. These factors include:

- Steam compensation
- **B**ody **T**emperature, ambient **P**ressure and **S**aturated with water vapour **BTPS**
- Pressure broadening (automatically always on)
- Gas mixing (automatically always on)
- Oxygen, nitrous oxide and desflurane or O_2, N_2O, desflurane

Art. no.: 2.540033 rev.: d

Correction for O_2

As the N_2 in the sample gas is replaced by O_2, the effect is a decrease in IR absorption. This results in a lower than actually measured CO_2 value ($CO_{2\ MEASURED}$). With the additional O_2 present, the raw measurement from the LC101 module must be increased be a slight factor to correct for the O_2 effect.

O_2 correction is recommended when the O_2 concentration is greater than 60%. At O_2 levels equal to or less than 60%, no correction should be made.

Correction for O_2, N_2O

To correct for N_2O in the sample gas, an assumption is made: if N_2O is administered to the patient, then the remaining balance of the administered mixture is O_2. The combined effect of these gases is two-fold. The presence of O_2 decreases the IR absorption, whereas the presence of N_2O increases the absorption. Although N_2O does not directly absorb the filtered IR energy, it causes the CO_2 molecule to absorb and pass along some of its energy to the N_2O molecule, which has a similar molecular weight. By passing off some of this energy, the CO_2 molecule becomes free to absorb even more energy, which leads to an increased absorption.

Since the increased absorption effect due to N_2O presence is greater than the decrease due to the O_2 presence, an optimal administered mixture of 25% N_2O and 75% O_2 effectively cancels the combined effect.

O_2, N_2O, desflurane compensation

The presence of the oxygen (O_2), nitrous oxide (N_2O) and desflurane in the gas sample affects the measurement of the CO_2 concentration, because these gases have the IR absorption characteristics of CO_2 molecules.

Correction for O_2, N_2O

The effect of desflurane on the CO_2 measurement is similar to the effect of N_2O. For desflurane concentrations above 12%, the N_2O correction may be applied.

Steam compensation (water vapour)

Water vapour compensation accounts for the effect that water vapour has on the IR absorption characteristics of CO_2 molecules. During normal sidestream operation, CO_2 measurements are adjusted mathematically to compensate for this effect.

The host may choose to disable this compensation when performing dry gas measurements in which the gas does not contain water vapour. Dry gas procedures may include steady state measurements and calibration procedures. Steady state measurements are performed only when background CO_2, or CO_2 present in the immediate environment, is measured. An example of a steady state measurement is measuring the CO_2 content inside an incubator. Calibration procedures use calibrated gas which is free of water vapour, or dry, as well.

BTPS

The clinician's intent is often to determine the CO_2 levels within the patient's lungs where the gas exchange takes place. BTPS compensation corrects for the environmental differences between the measurement site (i.e. the bench) and "deep lung" CO_2.

Art. no.: 2.540033 rev.: d

Occlusion

A total blockage in some region of the inlet tubing, or a total inlet occlusion, is typically caused by a kinked or occluded sample line, a fully saturated watertrap or an occluded secondary shutoff filter. In the event that this condition occurs, the pneumatic system increases the pump speed to achieve a high clearing vacuum (HCV) for 5 seconds. If the occlusion is cleared by this action, the pump returns to normal operation.

If the occlusion is not cleared after 5 seconds, the module automatically reverts to a hold, or low clearing vacuum (LCV) state, for up to 15 minutes. During this condition, the module responds to "*CO_2 Occlusion*" message bar (right on the top). If the occlusion is not removed after 15 minutes of LCV, the module reverts to the stand-by mode and a new measurement of auto run mode command must be issued to start CO_2 waveform and breath data packet transmission.

Leakage Test

A total inlet occlusion can be useful to check for internal pneumatic leaks. When the module goes into LCV state, the pump operation remains relatively stable in holding the vacuum.

However, if there are leaks within the overall system, the pump speed is increased to maintain LCV. The module may toggle between the normal and inlet occluded states depending on the magnitude of the leak. A specific connection may also be tested by blocking specific locations in the pneumatics.

Art. no.: 2.540033 rev.: d

4.4 ECG monitoring setup

Important
The guidelines for patient electrode placement are provided as an overview only. They are not a substitute for medical expertise.

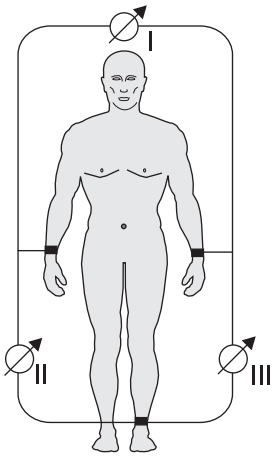
Following drawing are using IEC colour code. (see also chapter 4.4.9 page 39)

WARNING

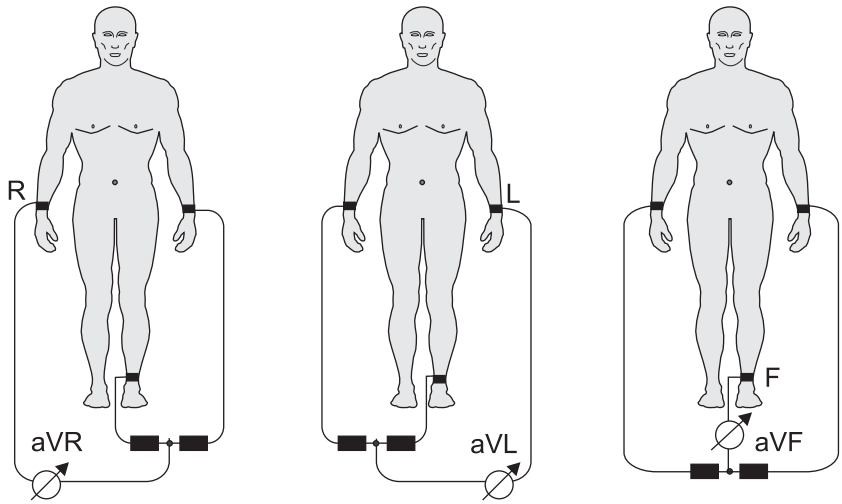
▲ Danger of destroying the device during defibrillation! The device is only type CF protected if the original SCHILLER patient cables are used.

4.4.1 Bipolar Electrode placement according Einthoven

Lead	AHA	IEC
I	LA - RA	L - A
II	LL - RA	F - R
III	LL - LA	F - L



4.4.2 Unipolar derivation and augmentation according Goldberger



aVR = R - 0.5 (L + F) aVL = L - 0.5 (L + F) aVF = F - 0.5 (L + RA)

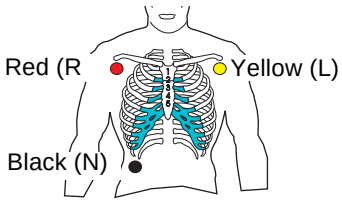
N electrode is used as CMRR (**C**ommon **M**ode **R**ejection **R**atio). electrode and electrode off can not be detected.

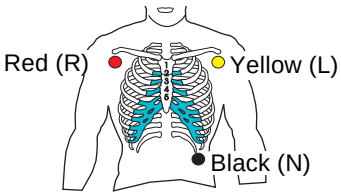
F electrode is the reference electrode for all derivations.

Art. no.: 2.540033 rev.: d

4.4.3 3-leads cable for children and neonates (LCM plus)

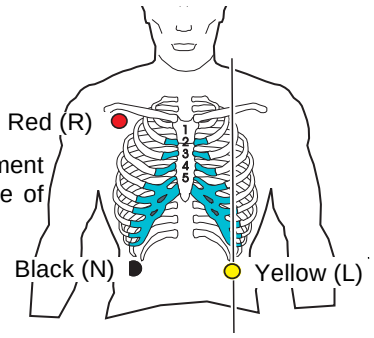
Electrode is the reference electrode for all derivations. Only derivation II is available



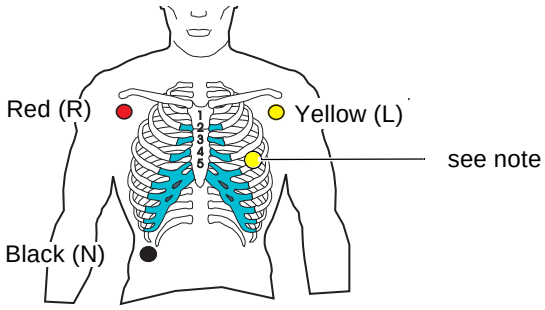


4.4.4 3-lead cable for respiration

Respiration measurement over the delta impedance of the peritoneum



4.4.5 3-lead cable for adults

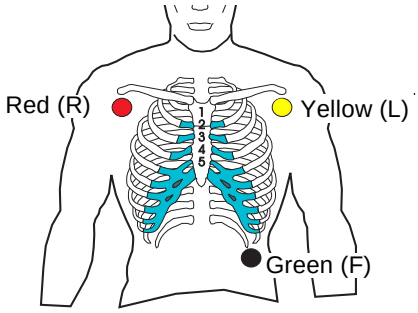


Note

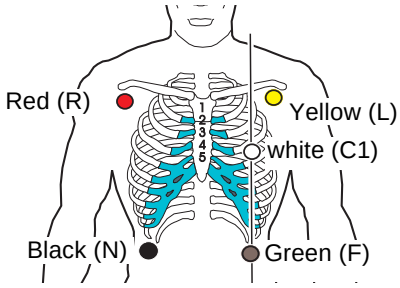
When the signal amplitude is < 0.5 mV, place the yellow electrode according the following picture instead to adjust the resolution to 40 mm/V. Because of that the artefacts can be reduzed.The signal amplitude is influenced by heart axis.

4.4.6 3 leads cable 3P (LCM basic)

This 3 lead cable 3P is supported only with the Monitoring ECG amplifier only. This amplifier is build in the ARGUS LCM with the Serial number 781.1000-xxxx, micro-processor board MK 19-11 and software 1.24 or higher. This combination display 6 derivations. 3 lead cable 3P attribute is R/L/F instead of N/R/L.



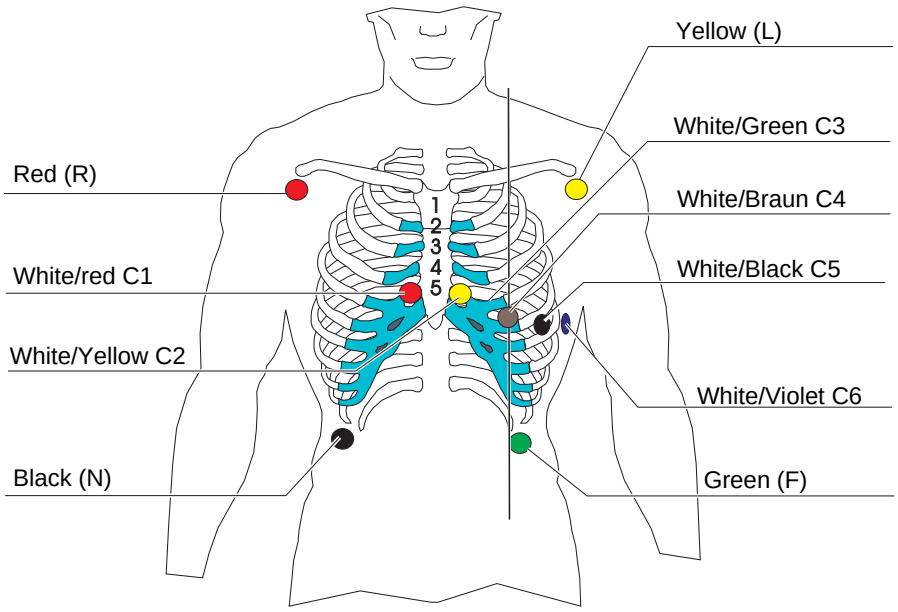
4.4.7 Three- and five-lead cables for adults and children (LCM basic/ plus



Art. no.: 2.540033 rev.: d

4.4.8 10-lead ECG patient cable (LCM plus)

The following illustration indicates the placement locations for the electrodes of a ten-lead patient cable.



4.4.9 Electrodes identification and colour code IEC/AHA

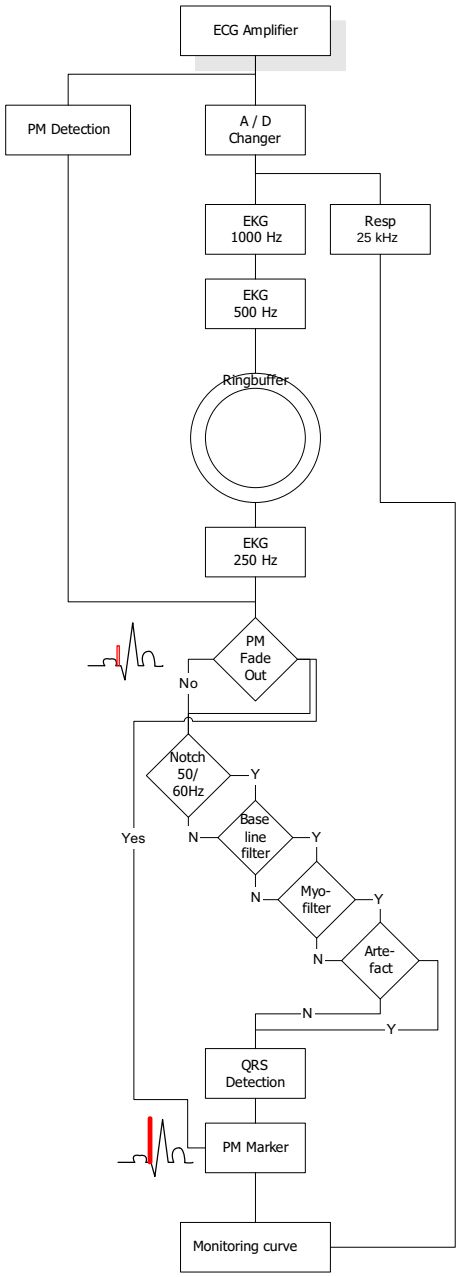
The electrode placements shown in this handbook are labelled with the colours according to code 1 requirements. The equivalent code 2 colours are given below.

	CODE 1 (usually European) IEC 60601-2-51		CODE 2 (usually American) AHA	
System	Electrode identifier	Colour code	Electrode identifier	Colour code
Limb	R	Red	RA	white
	L	Yellow	LA	Black
	F	Green	LL	Red
Chest according to Wilson	C	white	V	Brown
	C1	White/red	V1	Brown/red
	C2	White/yellow	V2	Brown/yellow
	C3	White/green	V3	Brown/green
	C4	White/brown	V4	Brown/blue
	C5	White/black	V5	Brown/orange
	C6	White/violet	V6	Brown/violet
Neutral	N	Black	RL	Green

4.4.10 ECG Processing

The incoming ECG signals are low-pass filtered and applied to non-inverting operational amplifiers. The signals are further low-pass filtered, ac coupled and amplified before being applied to the multiplexer. The left leg electrode to the patient is the signal ground reference signal. To assist in cancelling patient common mode noise and thus reducing incoming signal distortion, the signal from the patient left leg electrode is phase shifted 180°. This phase shifted signal is then used to cancel (or reduce) patient common mode noise via the right leg driver.

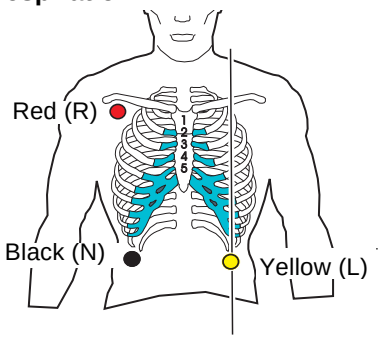
ECG Processing



Art. no.: 2.540033 rev.: d

4.4.11 Respiration measuring (RRi)

Respiration

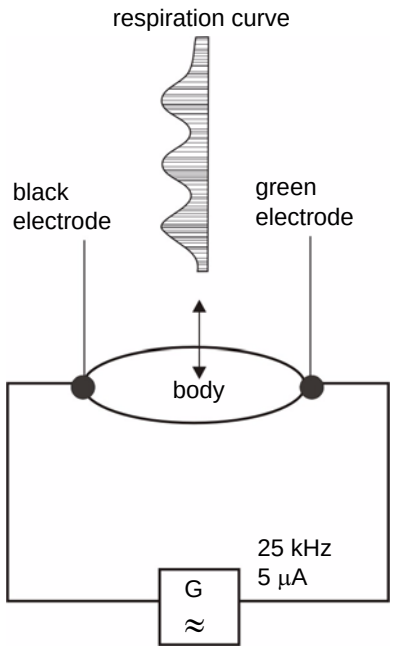


Respiration is measured between the left leg- and the right leg patient electrodes which are placed on the abdomen. The physical action of the patient breathing causes impedance change and this is used to detect and calculate respiration rate. The resistance across the electrodes is approximately 1 kohm + 250 ohm and the impedance change during respiration is between 0.1 and 3 ohm.

The input signals are modulated with 25 kHz, 5µA, which results in an amplitude modulated signal. This signal is then high pass filtered, demodulated and wave shaped and sent to the processor via the multiplexer.

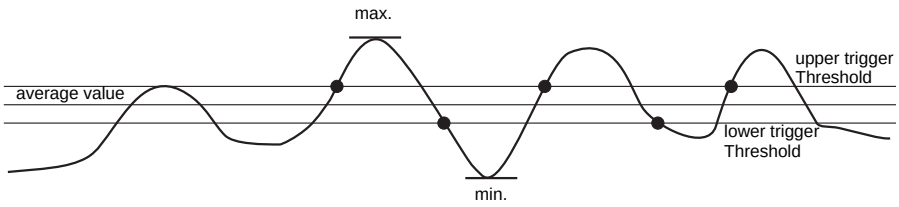
Respiration measuring not possible when using HF-cable

.



Respiration Detection

As with the ECG signal, it is necessary to first determine where a respiration has taken place (triggering). The respiration triggering in the ARGUS LCM is based on the following principle.

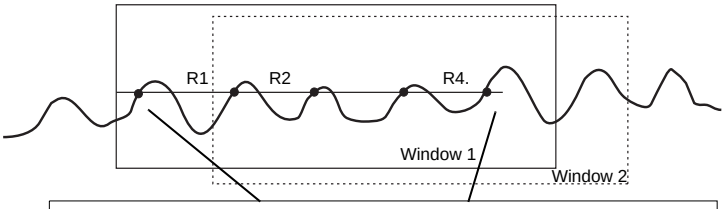


Picture: Determination of the Trigger Thresholds

Using a continuous time window of 32 seconds, the largest positive (max.) amplitude and the largest negative (min.) amplitude is determined. The mean value is then calculated from these two functions. The upper and lower trigger threshold is determined from this mean value.

Calculation of the Respiration Rate

The Respiration Rate is calculated as a continuous average according to the distances between the individual respirations. Only respirations which were triggered during the respiration detection, are averaged.



$$R_{average} = \frac{R1 + R2 + R3 + R4 + R5 + R6 + R7 + R8}{8}$$

$$R = \frac{60}{R_{average}}$$

The distances of 8 respirations are averaged. The respiration frequency is calculated out of the average R-distance $R_{average}$. This procedure is repeated for every inspiration

Art. no.: 2.540033 rev.: d

4.5 NIBP Processing

Overview Oscillometric technique

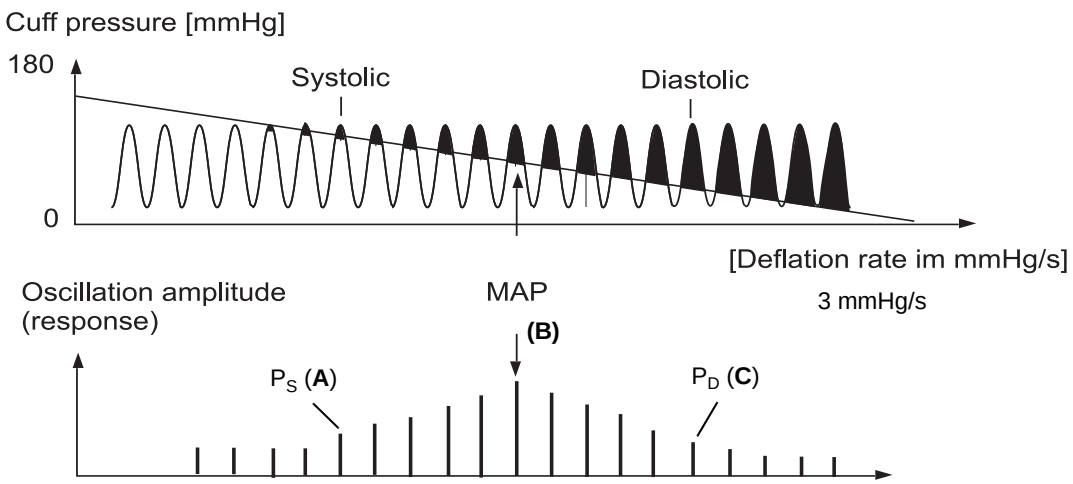
The oscillometric technique does not use Korotkoff sounds to determine blood pressure. The oscillometric technique monitors the changes in cuff pressure caused by the flow of blood through artery. Even when the artery is occluded, the pumping of the heart against the artery can cause small pressure pulses in the baseline pressure.

LCM NIBP processing

The LCM reduces the cuff pressure at controlled deflation rate. When the cuff pressure goes down, blood starts to flow through the artery. Above the systolic pressure the oscillation amplitudes are almost constant. The increasing blood flow causes to increase the pressure pulse amplitude in the cuff.
This is known as SYS, Systolic Pressure (**A**). These pressure pulse amplitude continue to increase with decreasing cuff pressure until it reaches maximum amplitude (**B**). The cuff pressure at which the greatest pulse amplitude is generated is known as MAP, mean arterial pressure. At this point the oscillation amplitudes getting smaller with decreasing cuff pressure. Before the amplitude stays constant small, it is the point to read out DIA, Diastolic Pressure (**C**).

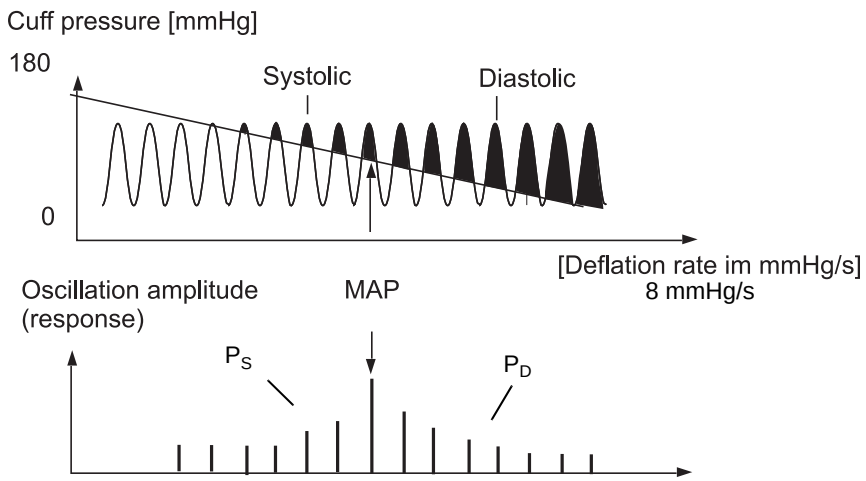
The manner in which the pulse amplitudes vary is often referred to as the pulse envelope. The envelope is an imaginary line that connects the peak of each pressure pulse and forms an outline. The shape of the envelope is observed by the monitor using a variety of techniques to determine the diastolic and systolic blood pressure.

4.5.1 Example at 3 mmHg deflation rate



Art. no.: 2.540033 rev.: d

4.5.2 Example at 8 mmHg deflation rate



Overall Accuracy Discussion

Overall system accuracy shall be determined by considering various influences of the pressure sensor accuracy, motion artifacts and other artifact created by pressure valve, technical errors of electrical components, and the origin error of oscillometric method.The origin error of oscillometric comes from the basic theory of that the MAP is determined by the pulse. Therefore, there might be an error of the time between two pulses. In another words, the greatest amplitude point of pulses could not represent the MAP point exactly.

Deflation rate

It is recommended to reduce the deflation rate for patient with bradicardia and hypotonia.

Initial pressure

If the initial pressure is to low and it is not possible to get a measuring, the pressure will be set as following:

Set Initial pressure [mmHg]	Increase if set pressure is to low [mmHg]	Increase if measurement was successful [mmHg]
Adult		
50...119	+80	+30
120...190	+60	+30
191...290	+50	+30
Children		
50...79	+60	+30
80...130	+40	+30
131...200	+30	+30
Neonatal		
50...59	+40	+30[a]
60...100	+30	+30[a]
101...140	+20	+30[a]

a. After a successful measuring the systolic pressure will be increased by 30 mmHg. At Neonate mode the initial pressure will be rounded down to the nearest ten and then increased by 30 mmHg.

Art. no.: 2.540033 rev.: d

4.6 Temperature measuring

Function Principle

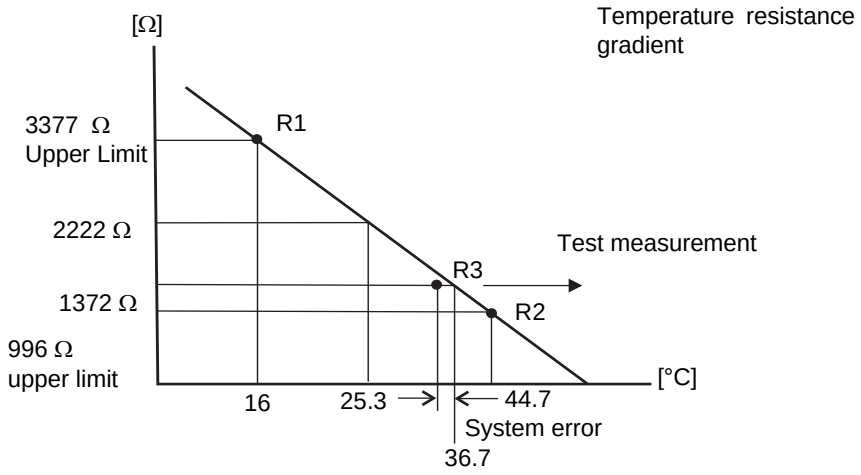
The resistance is temperature sensitive and registers different temperatures with varied Ohm values. The higher the temperature, the lower the Ohm value (NTC negative temperature coefficient). This Ohm value is measured and processed by the Monitor.

Temperature Amplifier

The temperature transducer contains a resistor with a known temperature coefficient (nominal value approximately 1300 ohms at 20°). The output from the temperature multiplexer is filtered and amplified and sent to the CPU via a second multiplexer and an opto coupler.

Temperature Calculation

The temperature is calculated using the temperature resistance gradient and the resistance values transmitted to the Monitor Unit:



Reference resistances are known resistances which are independent of temperatures. The temperature resistance gradient is determined using the two reference resistances R1 and R2. A further reference resistance R3 is used to check the measurement accuracy at any given time.

The resistance values (ohm values) measured in the ARGUS LCM are entered on the temperature resistance gradient. Therefore the temperature can be read from the temperature gradient.

Measurement accuracy of the System

Using the reference resistances R1 and R2, the temperature resistance gradient is determined and the upper and lower limits of the temperature measurement are simultaneously defined. Ohm values measured by the temperature sensor that are outside these upper and lower limits are invalid.

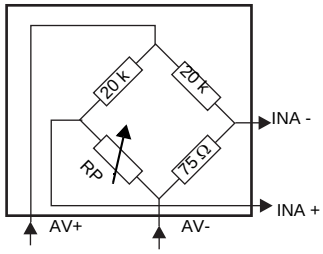
The reference resistance R* checks the accuracy of the temperature resistance gradient. If the deviation of its value to the temperature resistance gradients is too large, no value is shown. The system has to be checked

Defective Sensors or errors in the system are recognized and shown as "**<<**"(below 15 °C) or **">>"** (above 45 °C) in the measurement field and a technical Alarm appears.

Art. no.: 2.540033 rev.: d

4.7 Invasive blood pressure

Pressure Amplifier

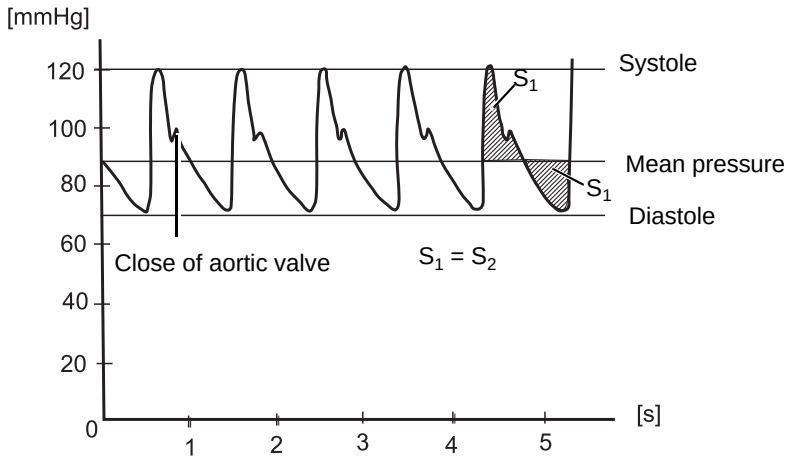


The pressure transducer contains a variable resistor in a bridge coupling as shown left. The impedance of the variable resistor is directly proportional to the pressure and so is the voltage between -INA and +INA.

Power for the pressure transducer is supplied via a voltage regulator and filter circuit. The resultant voltage between -INA and +INA is filtered and applied to a multiplexer. The output from the multiplexer is filtered and sent to the CPU via a second multiplexer and an opto coupler.

Example RP

mmHg	Resistance of RP [Ω]
0	75.1
30	74.5
50	73.9
100	72.7
200	70.1
300	67.7



Systole

The systolic pressure corresponds to the contraction of the myocard (pumping action of the heart muscle) and gives the upper peak value on the pressure curve.

Diastole

The diastolic pressure corresponds to the relaxation of the myocard (no muscle action of the heart) and gives the lowest point on the pressure curve.

Mean Arterial Pressure (MAP)

Clinically, the mean pressure is especially important if there are arrhythmias. It is calculated from the systole and diastole:

$$MAP = \frac{Systole + (2 \times Diastole)}{3}$$

Example:

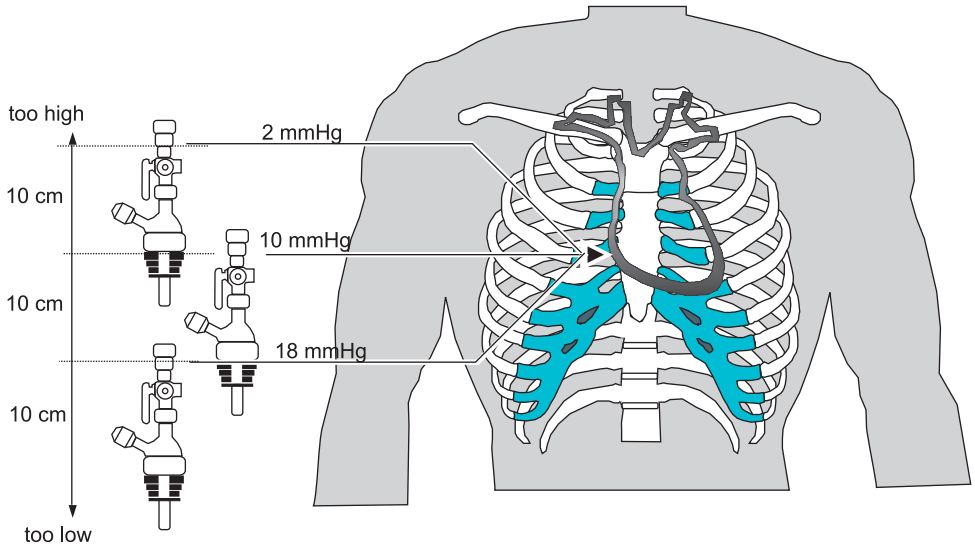
Systolic Pressure = 120 mmHg / Diastolic Pressure = 80 mmHg

MAP = 93 mmHg (rounded)

Art. no.: 2.540033 rev.: d

4.7.1 Influence of transducer placement

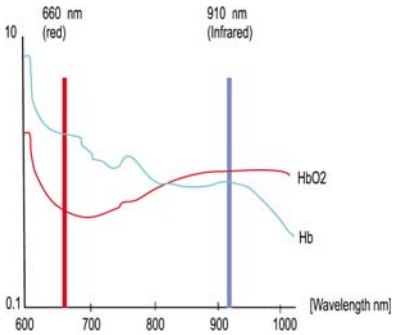
The correct placement of the sensor is important for a correct measurement of the invasive blood pressure. Altitude change after calibration causes wrong measuring of 8 mmHg/10 cm.



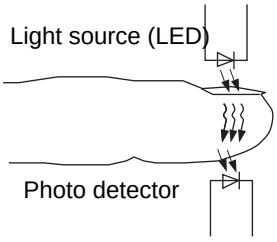
Art. no.: 2.540033 rev.: d

4.8 SpO_2 measuring

4.8.1 Principles of Pulse Oximetry Technology

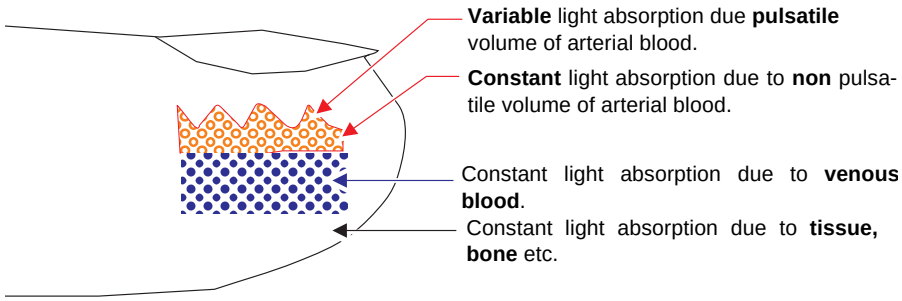


The principle of pulse oximetry is based on the red and infrared light absorption characteristics of oxygenated and deoxygenated haemoglobin. Oxygenated haemoglobin absorbs more infrared light and allows more red light to pass through. Deoxygenated (or reduced) haemoglobin absorbs more red light and allows more infrared light to pass through. Red light is in the 600-750 nm wavelength light band. Infrared light is in the 850-1000 nm wavelength light band.



Pulse oximetry uses a light emitter with red and infrared LEDs that shines through a reasonably translucent site with good blood flow. Typical adult/paediatric sites are the finger, toe, pinna (top) or lobe of the ear. Infant sites are the foot or palm of the hand and the big toe or thumb. Opposite the emitter is a photo detector that receives the light that passes through the measuring site.

After the transmitted red (R) and infrared (IR) signals pass through the measuring site and are received at the photo detector, the R/IR ratio is calculated. The R/IR is compared to a “look-up” table (made up of empirical formulas) that convert the ratio to an SpO_2 value. Most manufacturers have their own look-up tables based on calibration curves derived from healthy subjects at various SpO_2 levels. Typically a R/IR ratio of 0.5 equates to approximately 100% SpO_2, a ratio of 1.0 to approximately 82% SpO_2, while a ratio of 2.0 equates to 0% SpO_2.



At the measuring site there are constant light absorbers that are always present. This are skin, tissue, venous blood, and the arterial blood. However, with each heart beat the heart contracts and there is a surge of arterial blood, which momentarily increases arterial blood volume across the measuring site. This results in more light absorption during the surge. If light signals received at the photo detector are looked at ‘as a waveform’, there should be peaks with each heartbeat and troughs between heartbeats. If the light absorption at the trough (which should include all the constant absorbers) is subtracted from the light absorption at the peak then, in theory, the resultants are the absorption characteristics due to added volume of blood only; which is arterial. Since peaks occur with each heartbeat or pulse, the term “pulse oximetry” was coined. This solved many problems inherent to oximetry measurements in the past and is the method used today in conventional pulse oximetry.

Art. no.: 2.540033 rev.: d

Still, conventional pulse oximetry accuracy suffered greatly during motion and low perfusion and made it difficult to depend on when making medical decisions. Arterial blood gas tests have been and continue to be commonly used to supplement or validate pulse oximeter readings.

5 Maintenance

5.1 Service Interval

The device must be serviced in regular intervals. The test results must be documented and be compared with the values in the accompanying documents.

After successful calibration put the calibration sticker on the device with the date of the next calibration.

Maintenance work not described in this chapter, e.g. battery changes, may only be accomplished by a qualified technician authorised by SCHILLER AG.

The following table gives information about interval and competence of maintenance which can be required. Country specific regulations can prescribe additional or other intervals and examinations.

Interval	Service	Responsible
Every 6 months	• Keyboard test • LED test • Visual inspection of the unit, cables and sensors	➜ User
Every 12 months	• Every servicing of the six month interval • Functional tests according to the Service Handbook. • NIBP calibration • ECG calibration • Electrical safety tests according to IEC 60601-1, Clause 18 and 19	➜ By SCHILLER AG authorised technician
Every 24 months	• Every servicing of the 6- and 12 months interval. • Every measuring test and calibrations according to the service handbook.	➜ By SCHILLER AG authorised technician

Countries with specific regulations

Country	Directive	Description
Deutschland	MPBetreibV § 6	Sicherheitstechnische Kontrolle nach den genannten Vorgaben alle 12 Monate.
Oesterreich	ÖNORM E 8751-1	Sicherheitstechnische Kontrolle nach den genannten Vorgaben alle der Norm

5.1.1 Visual unit check

Defective units or damaged cables must be replaced immediately.

Visually inspect the unit and cables for the following damages:

➜ Device casing not deformed?
➜ Sheathings of sensor, mains and potential equalisation cables undamaged?
➜ Signal input sockets undamaged?
➜ Type plate on the rear of the unit readable?
➜ Keyboard and designation on the front of the unit readable?

5.1.2 Button test

Press all buttons and check if they work properly.

Art. no.: 2.540033 rev.: d

5.2 Measurement and Safety Check

These instruction describe which measurement and safety checks have to be carried out for the measuring parameters of the ARGUS LCM and how the checks are to be carried out.

5.2.1 Required measurement equipment

Simulator Phantom 320

Simulator HKP

Simulator MS410

Description	Part number
• ECG Patient simulator Müller+Sebastiani MS410 (IEC/AHA)	2.200241
• ECG Patient simulator HKP ARSI-2(AHA)	2.200218
• ECG Patient simulator Müller+Sebastiani Phantom 320 (AHA)	2.200215
• Pressure test cylinder 500 ml	3.910993
• Reference recorder ”Delta Cal” for invasive pressure	2.210055
• IBP/Temperature test box	2.320011
• IBP cable for test box	4.520677
• Temperatur cable for test box	4.520678
• SpO2 test plug Masimo	2.100433
• Nurse call tester	2.320012
• LCM-PC link cable	2.310208

Reference thermometer type:.....
The service department decides which type of reference thermometer is to be used.)

Multimeter:.....
(The service department decides which type of multi meter is used.)

Table YSI Thermistor Resistance versus Temperature in °C

Schiller AG develops and distributes a calibration kit for all parameters.

The safety/measurement checks must follow the test instructions of Schiller AG.

5.2.2 General test requirements

Whenever a device is opened for repairs or calibration, a functional and Safety Test has to be carried out at the end of the operation.

Safety Check

Before Measurement Check in every Case the Security Check has to be done first.

Environment Conditions

- Temperature: 18 ... 28 °C
- Relative humidity: 30 ... 70%

Measurement Devices

- Every Testequipemt used by technician needs to have a valid Calibration check.
- The service technician is responsible for the correct function of the measurement devices.

Art. no.: 2.540033 rev.: d

5.3 ECG Test

5.3.1 Amplitude Check

1. Connect a 10-lead ECG cable to Argus LCM plus or a 5-lead cable for Argus LCM basic.
2. Set the following filters:
   - ECG to Diagnostic
   - Pacemaker off
   - Mains filter off
   - Scale to 10 mm/mV
3. Set the height of Amplitude and the Heartrate at your simulator

hkp ARSI 2 ECG simulator settings:

- HR 60 bpm,
- amplitude 1 mV

➜ Press ⎍ button to generate at lead I a 1mV rectangular test signal.

Phantom 320 simulator settings:

- Connect RL/LL/LA/V1 to output RL and RA to output “1 mV ⎍“
- HR 60 bpm, amplitude 1 mV.

4. Measure the calibration rectangle at the screen or at a print out.
5. Check all cables.

Test criteria:

- Amplitude on the printout and screen is 10 mm ± 0.25 mm
- Heartrate is ± 1b/min

The square signal will be displayed distorted with the different filter settings.

Signal from Simulator | Signal with HW filter | Signal with HW + SW filter

5.3.2 Electrode and Patient cable Check

➜ To check the electrode resistance and the integrity of the cable, select in the menu extended menu About+/Software/Service/ECG leads and confirm with enter key.

This gives electrode dc offset and is the voltage drop in the patient cable. It can indicate any faults in the patient cable or patient electrode. The value given is the dc voltage between the left leg electrode and all other electrodes. The measurements obtained will indicate any cable short circuits or open circuits. The measured voltage value will depend on where the electrodes are connected.

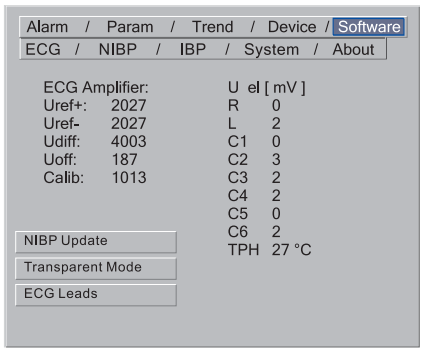


Fig. 5.1 Lead check

Test criteria U el [mV]:

- With patient connected (good connection, low resistance): -100 to +100mV.
  An offset of up to –300 to +300mV will give an acceptable recording.
- With patient simulator connected: -20 mV to +20
  This will depend on the patient simulator used and must be taken as a flexible measurement.
- With all electrodes shorted together: -20 mV to +20
- No patient cable connected: -350 to -500mV

Test criteria ECG amplifier:

- Udiff = 4000 ± 15 mV

Art. no.: 2.540033 rev.: d

5.4 SpO_2 test, Masimo

Use the specific Testplug for Masimo Module.
The Plug simulates a peripheral Pulsation Frequency (PP) a defined Saturation.

➜ Check values on the screen.

Test criteria:

- PP = 60 b/min ±1 with MS-3 board / MS-7
- Saturation = 85% ±3

5.5 Sp02 test Nellcor

No defined yet.

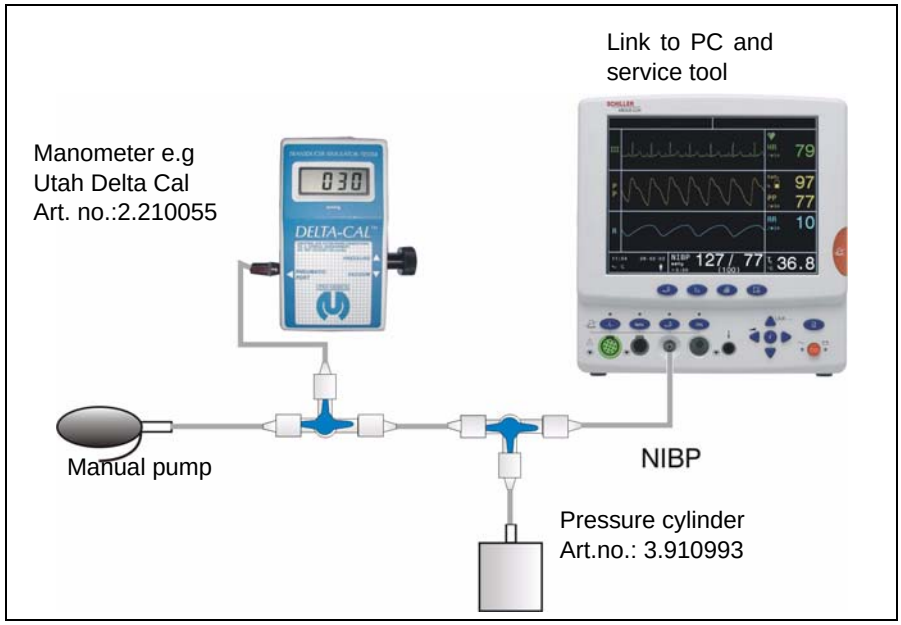
5.5 NIBP Test

- Argus PB-1000 Service Tool program.
- Link cable LCM-PC Art.no: 2.310208

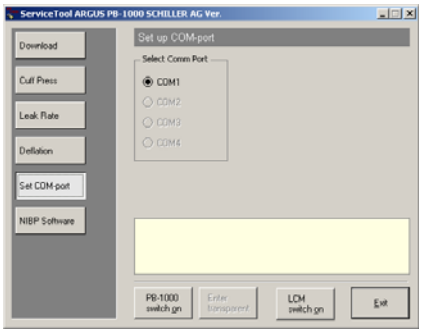
If you are using a NIBP-Simulator the result has to be same as described in the User manual of Simulator.

Test setup

The pressure cylinder has to be connected with 2 T-Pieces and 3 small hoses (like NIBP Connector hose). See scheme below.



Start up Service Tool program



1

1. Connect the PC to the RS-232 of the LCM.
2. Start the serviceTool.exe program.
3. Select the used Com port for the ARGUS LCM.
4. Select ARGUS LCM menu **About+/Software and** click on the button **Service** on the ARGUS LCM. The LCM switches to transparent mode and shows a black screen with the message **Transparent Mode**. The transparent mode is used for the following NIBP test.
5. Press on the Service Tool dialoge the button **LCM switch on (1)**. You will prompt to set the LCM into transparent mode.

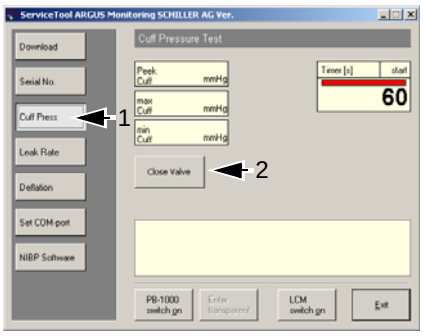
5.5.1 Cuff over pressure test

Over pressure control by software

Above 310 mmHg the relieve valve will be opened. The valve will be enabled, when the actual running timer is expired. (see **Timer** picture below)

Over pressure control by over pressure valve

Above approx. 330 mmHg the over pressure valve will be opened. A reset can be only executed by reset the NIBP module. Switch off LCM and set the LCM again to transparent mode.



1. Press the button **(1) Cuff Press**.
2. Press the button **(2) Close valve**.
3. Pump up and increase the pressure quickly to 300 mmHg.
4. Increase now the pressure slowly up to 335 mmHg.

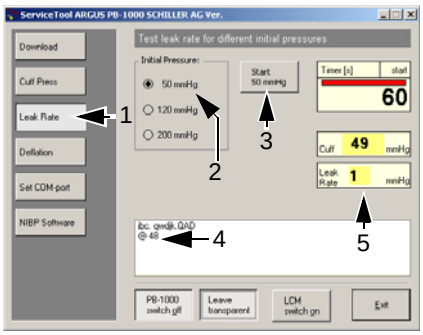
- The opening of the relieve valve is indicated by the smooth sound of the relieved air with accompanying slow deflation rate.
- The opening of the over pressure valve is indicated by the strong sound of the relieved air with accompanying fast deflation rate.

Test criteria:

- At 330 mmHg the valve has to open and the pressure must decrease to 0 mmHg.

5.5.2 Leak rate and cuff pressure tolerance test

This test runs automatically. When the pressure is reached and stable for 2 seconds the timer starts for 60 s. Note Pressure tolerance and the leak rate in the protocol



1. Press button **(1) Leak rate.**
2. Select the Initial pressure **(2) 50 mmHg**.
3. Press button **(2) Start 50 mmHg**.
4. Note the displayed pressure **(4)** for the tolerance and from reference pressure device.
5. Note the **Leak rate (5)** after 60 second.
6. Continue with step 2-5 with pressures of 120 and 200 mmHg.

Test criteria:

- Leak rate ± 6 mmHg between initial and cuff pressure.
- Pressure tolerance ± 3 mmHg between the displayed (4) and measured value on the reference pressure device.

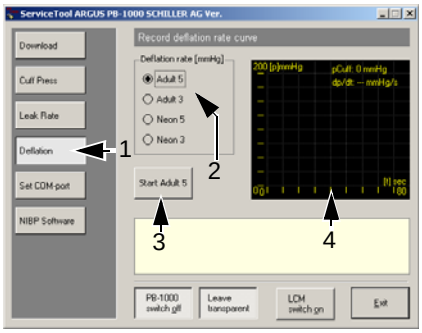
If the leak rate stays at ≅ 22 mmHg perform first the deflation test and proceed again with the leak rate test.

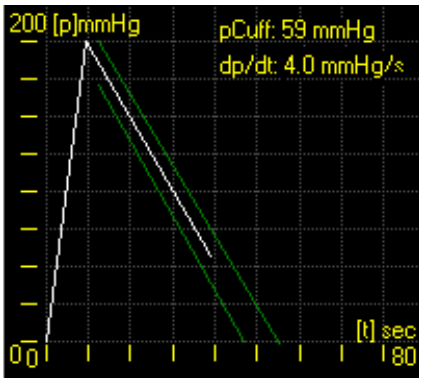
Art. no.: 2.540033 rev.: d

5.5.3 Deflation curve test

The deflation rate is defined as following:

Adult 5 = dp/dt 5 mmHg, Pmax 200 mmHg
Adult 3 = dp/dt 3 mmHg, Pmax 200 mmHg
Neon 5 = dp/dt 5 mmHg, Pmax 150 mmHg
Neon 3 = dp/dt 3 mmHg, Pmax 150 mmHg





1. Press button **(1) Deflation.**
2. Select the **Deflation rate (2)** e.g Adult 5.
3. Press the button **(3) Start Adult 5**.

The curve panel shows first the increasing pressure to the Pmax. value and then the declining curve till the test will be aborted, because the pulsation is missing. An error message 000 appears.

Test criteria:

- The value dp/dt is max. ± 1 mmHg of the selected value.
- The curve must be linear and not crossing the margin.

5.5.4 Measurement at a test person

1. The Parameter box has to be attached with a NIBP-Cuff to a Test person
2. Start one measurement.

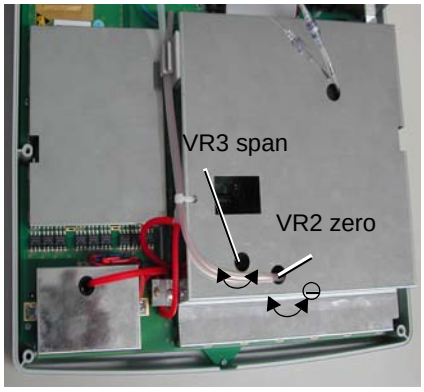
Test criteria:

- Verified by a manual Measurement of NIBP with a stethoscope. Both results has to verified to plausibility.

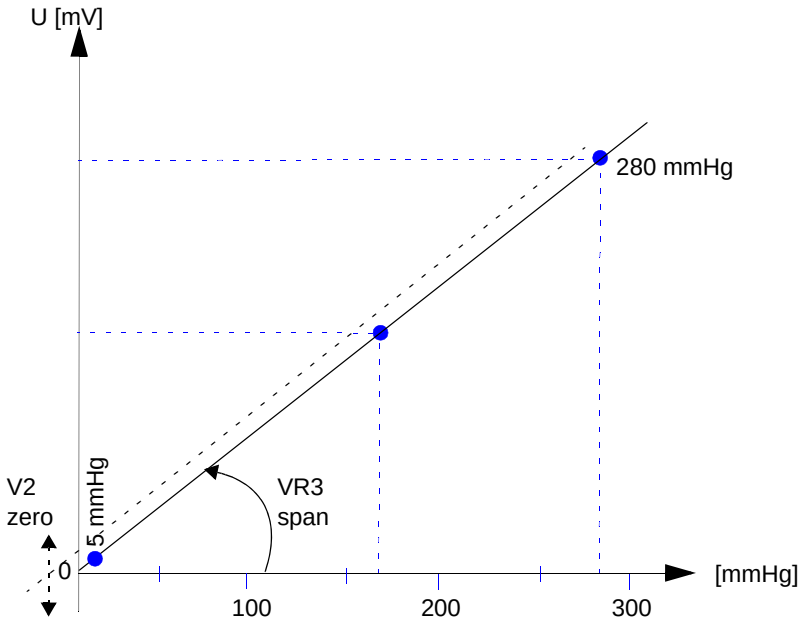
Art. no.: 2.540033 rev.: d

5.5.5 NIBP pressure calibration

A full NIBP test has to be carried out at the end of the calibration.



1. Set the LCM to transparent mode
2. Press the button **(1) Cuff Press**.
3. Press the button **(2) Close valve**.
4. Increase the pressure to approx.5 mmHg (Reading from the Digital reference manometer.
5. Use the VR2 zero potentiometer to adjust the displayed pressure exactly to 5 mmHg.
6. Increase the pressure to approx. 280 mmHg (Reading from the Digital reference manometer.
7. Use the VR3 span potentiometer to adjust the displayed Cuff pressure exactly to 280 mmHg.
8. Redo step 5-7 if necessary.
9. Secure both potentiometer by seal lacquer.



Art. no.: 2.540033 rev.: d

5.6 Invasive Blood pressure test

5.6.1 IBP test of the LCM

- IBP/Temperature test box Art. no.: 2.320011
- IBP cable for test box Art. no.: 4.520677
- Temperature cable for test box Art. no.: 4.520678

Fig. 5.2 IBP Testability

With this device you can test the logical unit inside the LCM.

1. Connect the test box to the IBP input.
2. Set the input IBP to zero.
3. Select the pressure at the test box and check the result at Argus LCM.

Test criteria:

- max. ±1 mmHg between displayed value and reference pressure.

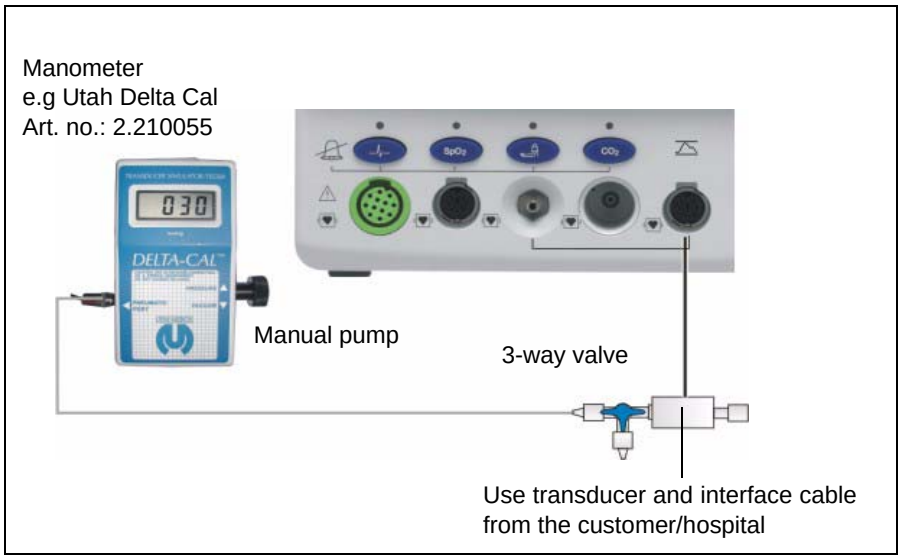
5.6.2 IBP test of the LCM and transducer

With pressure reference device ”DeltaCal” you can test the whole invasive pressure system (Main cable and Transducer). The big advantage of this method is that you can use a transducer system of your customer and test this environment if it is connected to our system.

1. Connect transducer and Digital manometer according the picture below.
2. Increase the pressure by using your manual pump in Steps of 50mmHg up to 300 mmHg. At every Step (0, 50, 100, 150, 200, 250 and 300 mmHg) note your pressure from the measurement field into your document.

Test criteria:

- max. ±1 mmHg (LCM) plus x %-tolerance of the transducer. (see transducer accuracy).



5.7 Temperature Test

5.7.1 Temperature test with IBP/temperature test box

1. Connect the test box to the temperature input.
2. Select the temperature.
3. Note the results from the temperature measurement fields shown at the screen.

Test criteria:

- max . ±0.1°C.
  If temperature is not in this range replace the module.

Art. no.: 2.540033 rev.: d

5.7.2 Temperature test of the sensor according German directive

Für die Bundesrepublik Deutschland gilt der entsprechende Absatz 15.1 der Eichordnung des Bundesamtes für das Eichwesen.

Die Temperaturaufnehmer werden in einem Wasser-Bad (definierte Temperatur zwischen 25° und 42 C ^{o} im Prüfprotokoll zu vermerken) eingetaucht und an der Testbuchse angeschlossen. Mit Hilfe eines geeichten Referenz-Thermometers wird die Wasser-Bad Temperatur gemessen.

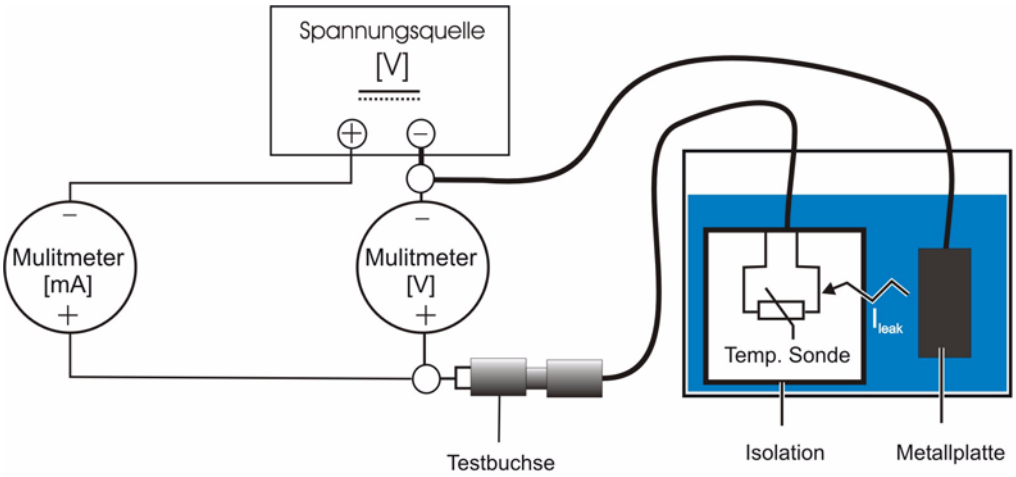
Um Messfehler zu vermeiden muss eine homogene Wasser- und Temperatur verteilung sichergestellt werden (z.B. durch einen Quirl)

Mit dem Multimeter (R) wird nun der Widerstand des Thermistors gemessen und mit Hilfe der Temperaturkennlinie des Temperaturaufnehmers in einen Temperaturwert umgerechnet. Die jeweiligen Werte werden ins Protokoll übernommen. Die Differenz zwischen dem berechneten Temperaturwert und dem gemessenen Wert des Referenz-Thermometers darf nicht grösser sein als 0.1 °C.

5.7.3 Messung des Isolationswiderstand des Temperaturaufnehmer

Der Temperaturaufnehmer wird ganz in den Behälter mit der physiologischen Kochsalzlösung eingetaucht und an der Testbuchse angeschlossen. Die beiden Kontakte der Testbuchse werden kurzgeschlossen. Die Testbuchse wird mit dem Multimeter (mA) an der Buchse (+) verbunden und in die Kochsalzlösung eingetaucht. Nun wird das Multimeter (-) mit der Spannungsquelle (+) verbunden und (-) der Spannungsquelle mit der Elektrode.

Die Ausgangsspannung der Spannungsquelle muss mit dem Multimeter (V) kontrolliert werden.



Der dabei fliessende Strom wird am Multimeter (A) abgelesen. Mit der Ausgangsspannung der Spannungsquelle kann nun der Isolationswiderstand berechnet werden:

$$R = \frac{U}{I}$$

Test Kiterium:

- Isolationswiderstand Ri > 3.89 MΩ

5.7.4 Calculation of resistance and temperatur

This tabel shows the calculation of the resistance for a defined temperatur display.

FINDING RESISTANCE AND TEMPERATURE USING STEINHART & HART EQUATION

1/T = a + b(Ln R) + c(Ln R)^3, T in degrees Kelvin

	Temp. [°C]	Resistance [Ω]	Temp. [°K]	LnR
Low	27	2064	300.15	7.6324011
Mid	34	1533	307.15	7.3349819
High	41	1152	314.15	7.0492548

Ln(R1) - Ln(R2)	0.29741925
Ln(R1) - Ln(R3)	0.58314629
(1/T1) - (1/T2)	0.00007593
(1/T1) - (1/T3)	0.00014847

Coefficients

a =	0.001474260
b =	0.000237025
c =	0.000000109

Solving for R, given T:		**Resistance [Ω]**	**dR/dT**	**%dR/dT**	**alpha**	**beta**
Temp. **[°C]** =	1	6983.66	-353.87	-5.07	-19991.32343	21994.14804
Temp. **[°K]** =	274.15					

Solving For T, given R:

Ohms =	28137	Temp °C =	-24.36

Temp °[°C]	**Resistance [Ω]**	**DRDT**	**alpha**	**beta**
23.60	2'395.34	-106	-17436.06	21443.72504
27.80	1'993.80	-86	-17003.476	21356.70494
34.50	1'501.46	-62	-16337.851	21226.41372
38.00	1'300.26	-53	-16001.535	21162.26775
42.10	1'102.54	-44	-15617.063	21090.34037

5.8 CO_2 Calibration

- CO_2- Scrubber not older then one year (when the grey pellets are turned to purple or tourqoise replace the scrubber. (2.100424)
- Sure CO_2 sample line art no. 2.100439
- Calibration gas 10% CO_2 Bal. N_2
- Or calibration kit including above items and accessory Art.no. 2.100741

- Calibration of the Zero voltage of the sensor at dry, clean air (Zero CO_2) at room temperature.
- The Zero calibration will be executed every two weeks. Zero point calibration is successful when the CO_2 value is between 0.0 and 0.3%.
- The 2-point calibration will be executed every 6 month. During this calibration a Zero point calibration will be automatically executed. A Two point calibration is successful when the CO_2 value is at 10% after 1 minute.
- The date of the calibration will be stored and displayed in the menu CO_2. If the calibration interval expires a message will be displayed.
- Before calibration the CO_2 needs a warm-up time of 5 minute. To reduce calibration time set in the menu About/Param the value Respiration source to CO_2. The pump starts as soon escaping the menu.
- Change CO_2 unit to Vol.% in the menu About/Param.

CAUTION

▲ Read first the safety notes of the CO_2 gas bottle.

▲ Do not apply any pressure directly to the module inlet or outlet.

5.8.1 Start zero point calibration

1. Attach sample line at the CO_2 connection.
2. Set Respiration source to CO_2 in the menu About/Param.
3. Select in the menu CO_2 Start Zero **point calibration** and confirm with the **Enter** key. The pumps will be started.
4. Press the **Enter** key to go ahead. A prompt appears to attach the CO_2- scrubber.
5. Attach the CO_2- scrubber (**2**) at the sample line (**1**).
6. Press the Enter key to go ahead. The pump has to run 5 minutes before a calibration can be executed.
7. When the calibration is successfully terminated a message appears. Use the **Enter** key to escape from the calibration menu.

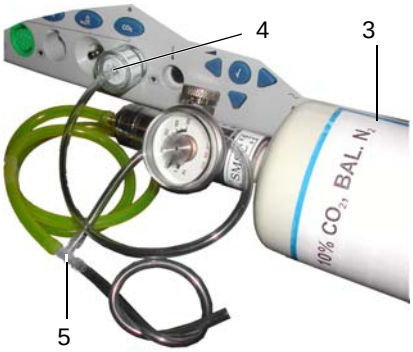
Test criteria:

- CO_2 = 0.0 till 0.3%

Art. no.: 2.540033 rev.: d

5.8.2 Start two point calibration

- The two point calibration includes the zero point calibration.
- Instead of the watertrap **(1)** you can use also the Sure CO2 sample line



1. Attach watertrap at the CO_2 connection. (see zero point calibration)
2. Set Respiration source to CO_2 in the menu **About/Param**.
3. Select in the menu CO_2 **Start Two point calibration** and confirm with the **Enter** key. The pump will be started.
4. Press the **Enter** key to go ahead. A prompt appears to attach the CO_2- scrubber.
5. Attach the CO_2- scrubber (**2**) at the watertrap (**1**).
6. Press the **Enter** key to go ahead. The pump has to run 5 minutes before a calibration can be executed. When the calibration is successfully terminated a message appears with the prompt to connect the calibration gas.
7. Remove the CO_2 scrubber and connect the calibration gas (**3**) with a Tee connector (**5**) at the watertrap (**4**).
8. Open the regulator of the gas bottle. eCO_2 value shows a value of about 10%. Allow the reference to flow for at least 1 minute. and executed automatically the calibration
9. When the calibration is successfully terminated a message appears. Use the **Enter** key to escape from the calibration menu.

Test criteria:

- CO_2 value = 10% after 1 minute

Verification of calibration

For measuring test by reading gas out of bottle the compensation factor needs to be switched off.

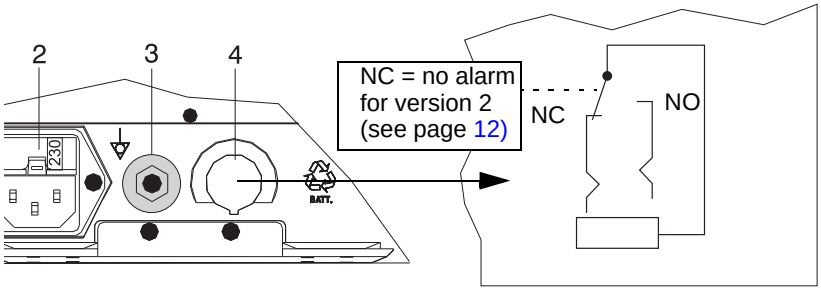
Art. no.: 2.540033 rev.: d

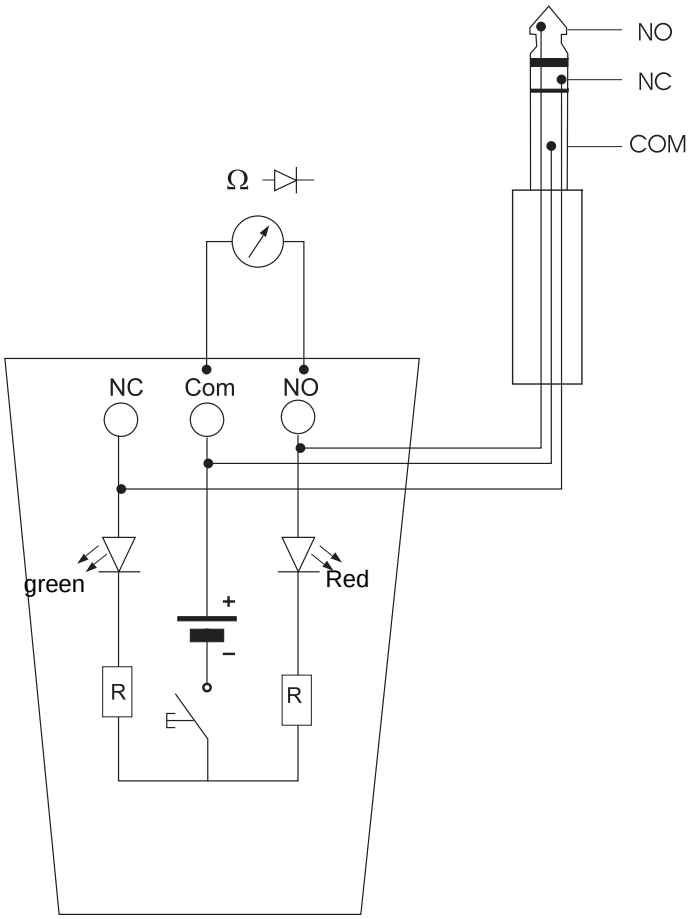
5.9 Nurse call test

Nurse call tester Art. no.: 2.320012 or multimeter

The output can be tested also with a multimeter.

1. Connect the tester to the Nurse call input of the LCM.
2. Generate an alarm. The light has to change from green to red.





5.10 Safety Tests

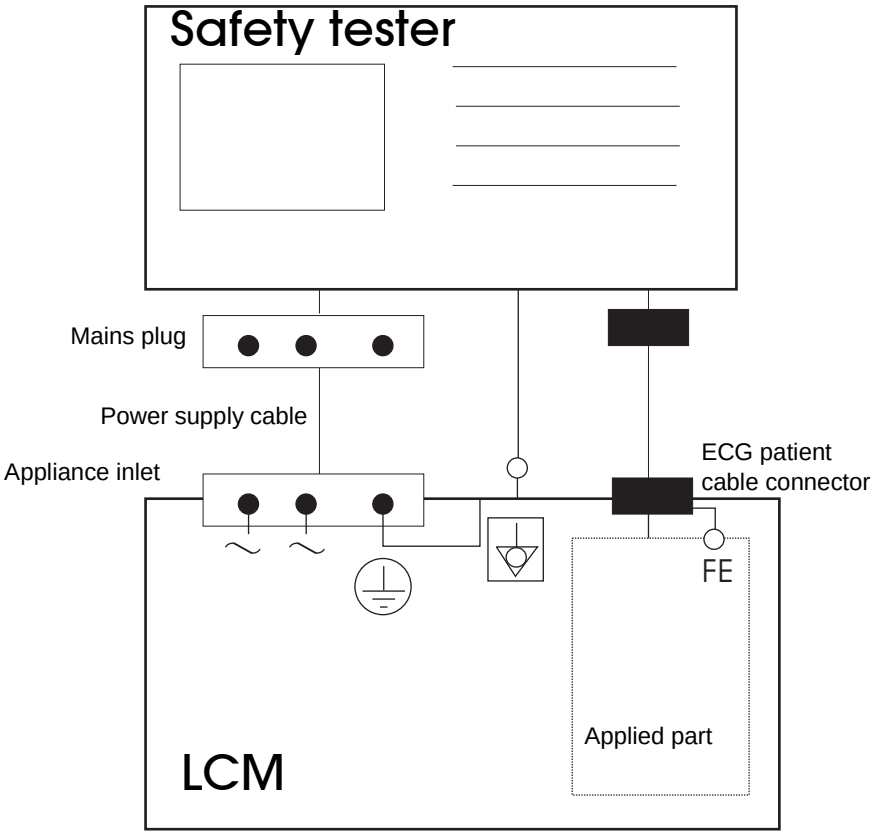
The safety test is carried out in accordance with the IEC/EN 60601-1, Clause 18 and 19. This test may only be carried out with a tester that fulfils the above mentioned norms and has been calibrated in accordance with ISO norms.

To carry out the test, follow the instructions of the manufacturers.

Documentation

Note the results or have them printed by the test device. Always include one copy of the results with the repair report. The original remains with the device and is given to the customer for his files.

Test setup for test 4.1.9 and 4.9.2.



Protective earth

Potential equalization

FE = Functional earth (screen cabel to applied part shielding).

Art. no.: 2.540033 rev.: d

5.10.1 Protective earthing, functional earthing and potential equalization

According IEC/EN 60601-1, Clause 18

Test criteria:

- **Ground Resistance:** ≤ 0.2Ω measured with the mains cable.

5.10.2 Continuous leakage and patient auxiliary current

According IEC/EN 60601-1, Clause 19

Voltage	Type CF	
	normal condition	first error
Earth current general [mA]	0.5	0.5
Shell current [mA]	0.1	0.5
Patient current [mA]	0.01	0.05
Patient current [mA] (Mains voltage at signal entrance and exit)	--	--
Patient current [mA] (mains voltage at used part)	--	0.05
Patient independent current [mA]	0.01	0.05
Direct Alternating Current [mA]	0.01	0.05

5.10.3 Dielectric strength

Only executed by the manufacturer.

According IEC/EN 60601-1, Clause 20

Tested insulation	Test voltage for reference voltage U in [V]				
	U ≤ 50	*50 < U ≤ 150*	*150 < U ≤ 250*	*250 < U ≤ 1000*	*1000 < U ≤ 10000*
Basic insulation	500	1000	1500	2 U + 1000	2U + 2000
Supplementary insulation	500	2000	2500	2 U + 2000	U + 3000
Reinforced or double insulation	500	3000	4000	2(2 U + 1500)	2(U + 2500)

5.11 Maintenance interval for the battery

CAUTION

▲ Total discharge of the lead battery can cause irreparable damage.

▲ Lead acid battery needs to be recharged every 3 months if not used to prevent permanent performance degradation.

- during normal operation no maintenance is necessary.
- If not used every 3 months.

replace the battery approx. every 4 years (depending upon application) if the actual running time falls substantially under 1 hour.

5.11.1 Checking the battery

A 12 V battery has 6 cell with a max. voltage of 2.275 V. That means that a new fully charged 12 V battery can have an open-circuit voltage (o.c.v.) of about 13.6 V. That is also the reason that the charging voltage is adjusted to 13.6 V.

➜ Measure the open-circuit voltage by means of a voltmeter. If the open-circuit voltage (o.c.v.) drops below 12,5 Volt, then top-charging is mandatory. Recharge and check whether the battery recovers to an o.c.v. greater than 12,6 V some 12 hours after the top-charging.

o.c.v [V]	Capacity [%]
12,8-13,0	100
12,6-12,8	80
12,3-12,5	60
11,9-12,2	40*
11,7-12,0	20
11,2-11,8	0

➜ *If the battery o.c.v is below 12 V after recharging replace the battery.

CAUTION

▲ A voltage below 10.5 V or below 1.75 V /cell will damage the battery.

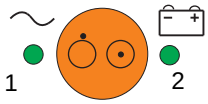
Art. no.: 2.540033 rev.: d

5.11.2 Charging the battery

Important

A totally discharged battery requires approx. 5 hours to be 90% recharged.

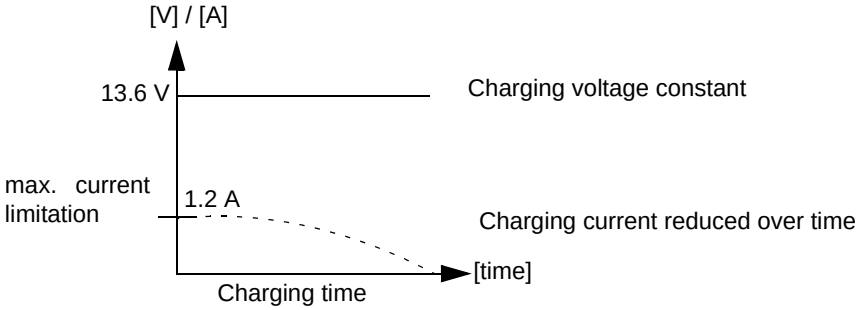
It is possible to use the unit when the battery is being charged. However, when this is the case, the charging time of the battery will be substantially extended!



1. Connect the device to the mains but do not switch it on.
2. The LED for mains supply (1) is lit.
3. Charge the battery for at least 5 hours.

Checking the charging circuit

➜ Measure the charging voltage at the battery. It must be approx. 13.6 V max. 1.3 A.



5.11.3 Replacing battery

- Phillips screw driver size 1
- Lead acid battery 12 V, 2.6 Ah p/n 4.350023
- Alternative lead acid battery Yuasa12 V, 2.3 Ah, p/n 4.350005

1. Disconnecting the device from the mains.
2. Loosen the 3 Phillips screw from the battery cover.
3. Remove the cover.
4. Take the battery out and remove the cable.
5. Insert a new battery and connect the cable. Check the polarity.
6. Charge the battery. see section 5.11.2.

Fig. 5.3 Battery replacement

5.11.4 Adding second battery

- Optional battery set p/n 3.920906 incl.:
  - Lead acid Battery 12 V, 2,6 Ah p/n 4.350023
  - Connecting cable p/n 4.520601

1. Disconnecting the device from the mains.
2. Loosen the 3 Phillips screw from the battery cover.
3. Remove the cover.
4. Insert a new battery and connect the cable to P7 of the MK-10-53 print (see page 122.
5. Fix the cable with a tyrap.
6. Charge the battery. see section 5.11.2

5.11.5 Battery disposal

WARNING

▲ Danger of explosion! Battery may not be burned or disposed of domestic refuse.
▲ Danger of acid burns! Do not open the battery.

The battery is to be disposed of in municipally approved areas or sent back to SCHILLER AG.

Art. no.: 2.540033 rev.: d

5.12 Changing the fuse and mains voltage

WARNING

- ▲ The mains voltage may only be changed by qualified personnel.
- ▲ Before the fuse and mains voltage are changed, the device must be disconnected from the mains and remove the mains plug. See section 3.2.
- ▲ The fuse may only be replaced by the indicated fuse type.

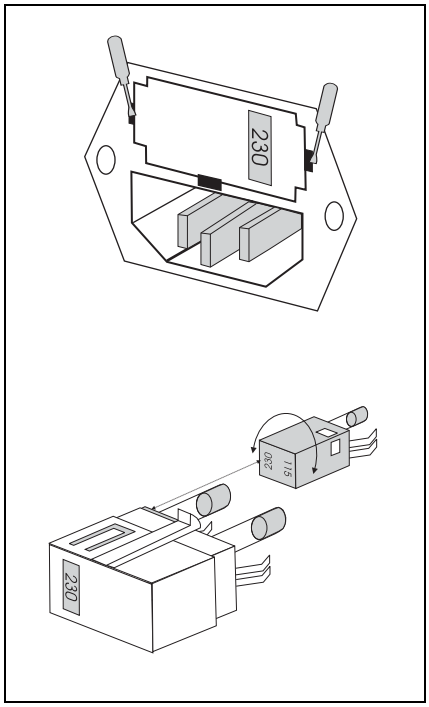


Fig. 5.4 Fuse inset

Changing the fuse

1. Disconnect the device from the mains and remove the mains plug. See section 3.2.
2. Loosen the fuse inset using a screwdriver and remove it.
3. Replace both fuses.
   250 VAC 2 x 200 mA (T), 115 VAC 2 x 315 mA (T)
4. Re-insert the fuse inset.

Changing the mains voltage

1. Disconnect the device from the mains and remove the mains plug. See section 3.2.
2. Loosen the fuse using a screwdriver and remove it.
3. Remove the grey inset, turn it by 180° and re-insert it.
4. Check the voltage indication in the window.
5. Replace both fuses for the selected voltage as follows:
   – 250 VAC 2 x 200 mA (T) p/n 4.210010
   – 115 VAC 2 x 315 mA (T) p/N 4.210032
6. Re-insert the fuse assembly.

Art. no.: 2.540033 rev.: d

5.13 Trouble shooting

5.13.1 Alarm messages, cause and remedy

Alarm	Cause	Remedy
ECG cable off	• ECG cable disconnected	➜ Connect the ECG cable.
ECG lead off	• Electrode lose/defective	➜ Check and reapply/replace electrodes.
SpO_2 Low Perfusion	• Bad sensor positioning	➜ Check the sensor and reapply.
SpO_2 Sensor off	• Sensor off	➜ Check the contact between the sensor and the patient.
SpO_2 no sensor	• SpO_2 sensor failed or disconnected	➜ Replace the sensor.
NIBP no module detect.	• NO NIBP module detected	➜ Switch device Off/On or replace device.
NIBP error	• NIBP module failed	➜ Replace the device.
NIBP no/off cuff	• No cuff connected or insufficiently fitted. • Pump is not running • Pump is running • Pressure offset above 8 mm/Hg see page 16	➜ Check the cuff position. ➜ Pump is mechanical blocked ➜ Pump not or wrong connected ➜ Internal tubes off ➜ Adjust the zero point of the NIBP module. Call service.
NIBP signal low	• Cuff not applied correctly • Pulse too low for good measurement • Tube too long for neonates	➜ Reposition/check the cuff. ➜ Use a tube for neonates (max. 1.5 m).
NIBP pressure range	• Pressure min. 15 mm/Hg max. 310 mm/Hg below or above the limit	➜ Check cuff and connection.
NIBP time too long	• Pump running time exceeded (40 s for neonates, 60 s for adults)	➜ Check cuff and connection for leaks ➜ Pressure approx. 50 mmHg when pump is running check valve ➜ Internal tubings
CO_2 No watertrap	• Watertrap not connected • Microswitch defective	➜ Check the watertrap. ➜ Check the microswitch.
CO_2 module failure	• CO_2 module defective	➜ Replace the device.
CO_2 Communication	• Communication interrupted	➜ Replace the device.
CO_2 Environment dist.	• Temperature, or barometric pressure of the CO_2 sensor outside the range • Pump damaged • Air or vacuum source connected to the CO_2 input	➜ Check the environmental conditions. (call service) ➜ Inspect the pump. ➜ Inspect the connection.
CO_2 Occlusion	• Tube system clogged	➜ Check the tube system and watertrap for occlusion.
Temp. Sensor off	• Sensor removed.	➜ Reconnect the sensor.
Temp. out of range	• Temperature out of range of 15 °C to 45 °C.	➜ This limit is fixed. The display shows **“<<“**(below 15 °C) or **“>>”** (above 45 °C).
Temp. failed	• Sensor failed	➜ Replace the sensor.
IBP no sensor	• IBP sensor failed	➜ Replace the sensor.
		Table page 1 of 2

Art. no.: 2.540033 rev.: d

Alarm	Cause	Remedy
IBP not calibrated (nKal)	• During calibration sensor under pressure higher than ± 30 mmHg or pressure variations.	➜ Check tube system, sensor and valve ➜ Calibrate the sensor.
IBP Artefact	• Loose sensor contact • A manipulation at the sensor, such as rinsing, has caused variation peaks ± 150 mmHg	➜ Inspect the sensor and cable connection. ➜ After rinsing, calibrate the sensor.
IBP false value	• Constant pressure (± 30 mmHg) during calibration	➜ Check tube system, sensor and valve. Set the sensor to ambient pressure ➜ Calibrate the sensor.
Paper insert	• Paper finished	➜ Insert new paper.
Check paper	• Paper jammed	➜ Check the paper.
Battery low	• Battery capacity too low	➜ Connect the device to the mains and recharge the battery.
Respiration curve field is not shown	• Pacemaker is **On** and respiration source is **ECG**	➜ Set respiration source to **CO_2** (Version B) or pacemaker to **Off**.
Respiration curve is not displayed	• HF ECG cable connected	➜ Connect standard ECG cable
No QRS sound	• Setup QRS source	➜ Set QRS source to SpO_2 or ECG
		Table page 2 of 2

Art. no.: 2.540033 rev.: d

6 CO_2 Installation

Minimum Request:

This upgrade requires software version 1.10 or higher

- Philips Screwdriver, PH1, PH2
- Flat pliers
- Soldering iron
- Protective facilities, ESD mat, wristband
- Countersink
- Edge cutter
- Solder
- Calibration gas

6.1 Scope of delivery

LCM upgrade kit CO_2 Art. no: 2.100748

Description:	Art. no.	Quantity:
Distance bolt M2.5*19 PA, black	4.430208	4
Philips-Screw 2.5*8	4.910011	7
Countersunk screw M2.5*8	4.914020	1
CO_2 module, LC-101 Pryon	4.150108	1
Zero ohm resistor	4.715000	1
Water trap receiver grey	4.150140	1
Power-Data cable (4 wire)	4.520495	1
Connecting cable (micro switch) (2 wire, blue)	4.520608	1
Cable tie (100mm)	4.530007	5
Airway Adapter, Andros box of 25	2.100436	1
CO_2 Scrubber Box, CO2 absorber, box of 5	2.100424	1
Sure CO2 sample line	2.100439	5

6.1.1 Illustration catalogue

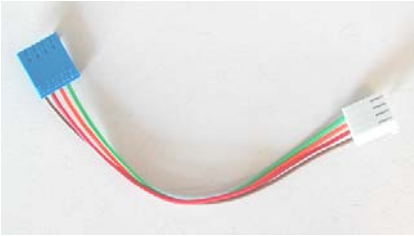


Fig. 6.1 Power data cable 4.520495

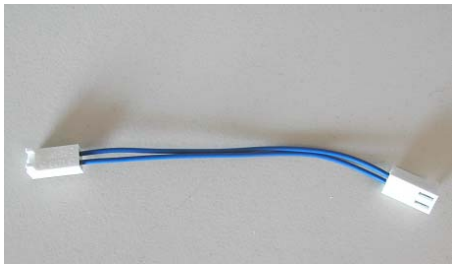


Fig. 6.2 Micro switch cable 4.520608

Fig. 6.3 Secondary shut off filter 4.150162

Fig. 6.4 Watertrap receiver 4.150140

Fig. 6.5 CO_2 module LC101 4.150108

Fig. 6.6 Scrubber attached to watertrap

Fig. 6.7 Watertrap 2.100425

Fig. 6.8 CO_2 scrubber 2.100424

Fig. 6.9 Airway adapter 2.100436

Fig. 6.10 CO_2 sample line 2.100422
replaced by 6.13

Fig. 6.11 Nasal canula adult 2.100426

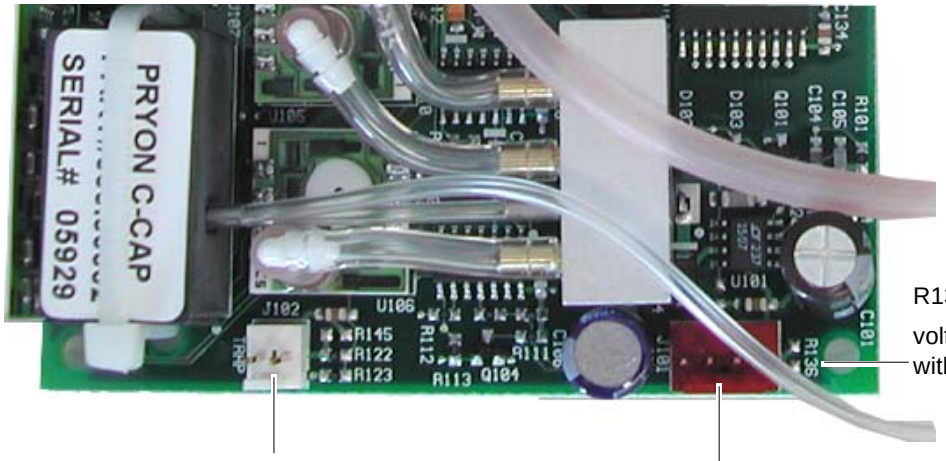
Fig. 6.12 CO_2 calibration kit 2.100741
10 CO_2 balance

Fig. 6.13 Sure CO_2 sample line 2.100439

6.2 Installation

Observe precautions for handling electrostatic sensitive devices such as all electronic circuits of the LCM.

6.2.1 Preparation



R136
voltage selection with zero ohm resis-

J102, micro switch watertrap receiver
J102 -> MK19 / MK19 ->micro switch

J101
power and Data

Fig. 6.14 Pryon LC 101 CO_2 module

Next to the brown module interface connector (J101) are two contacts, labelled with R136. This input voltage selection has to be set on 5 volts, therefore R136 needs a zero ohm resistor (short-circuit).

Pin	Signal	Signal description of J101 4-pin Molex connector
1	Vin	Input power (the "square" plated-through hole designates pin 1 on the module
2	Gnd	Ground
3	TXD	Data from module to host system (LCM)
4	RXD	Data from host system (LCM) to module

Art. no.: 2.540033 rev.: d

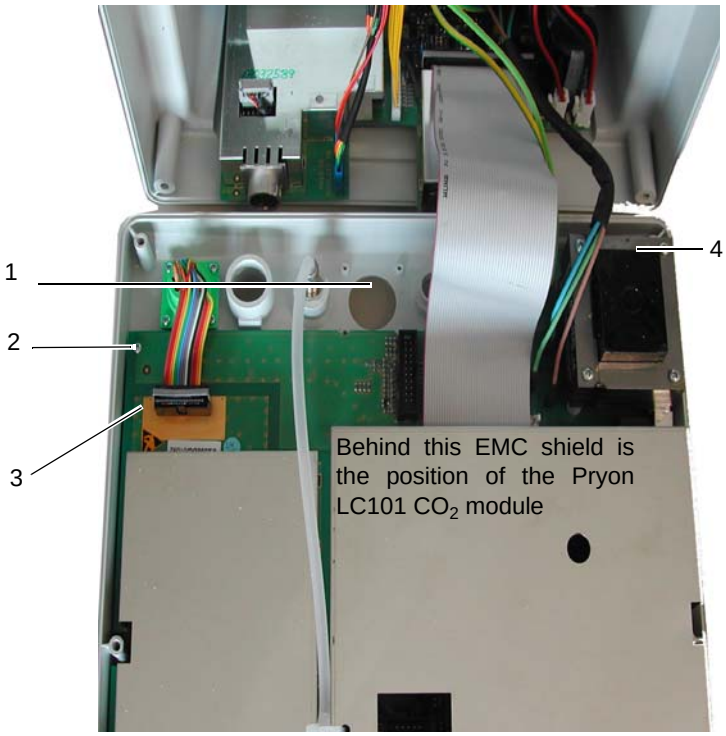


Fig. 6.15 Open LCM

1. Remove 6 screws from the backside and carefully open the LCM.
2. Remove 10 screws (**2**) of the MK19-1D PCB
3. Disconnect ECG connector (**3**)
4. Remove 4 screws of the transformer (**4**)
5. Remove the cover plate (**1**) see Fig. 6.16. The four screws are used later on to fix the LC 101 module.

Fig. 6.16 Cover plate

6. Take the micro switch of the receiver, to get access to the 4th screw
7. Fix the receiver with four screws 2.5*8 (4.910011), then fit the micro switch. It has to be engaged in the receiver.

Fig. 6.17 Watertrap and micro switch

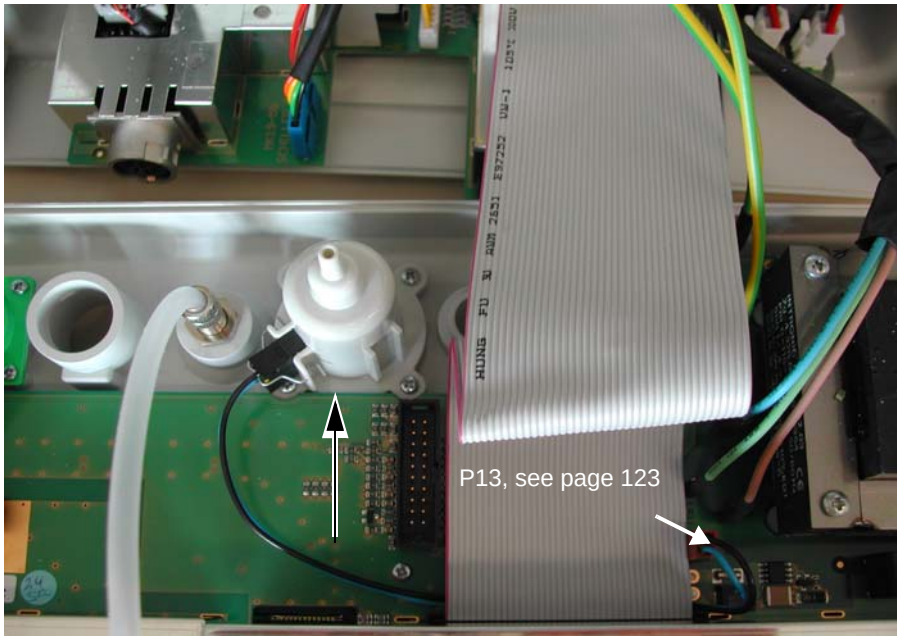


Fig. 6.18 Receiver mounting

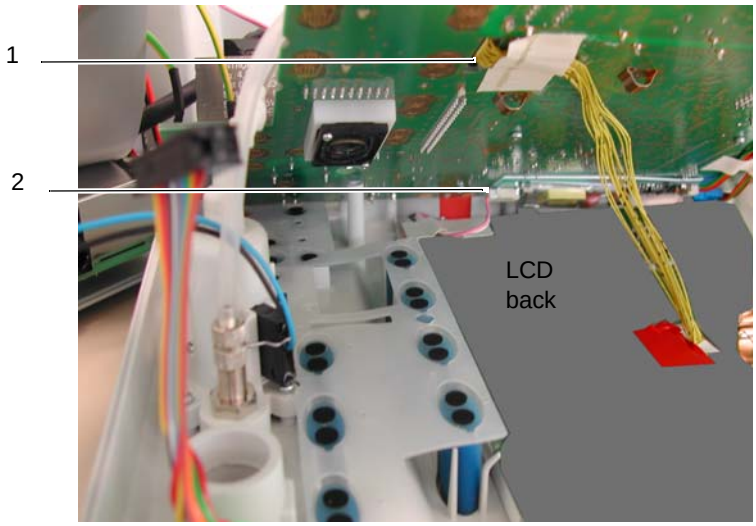


Fig. 6.19 Lifted MK19-1 PCB

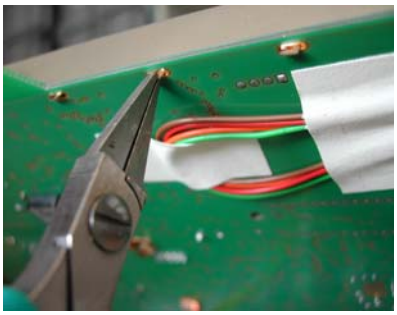


Fig. 6.20 Removal of EMC shield

8. Carefully lift the MK19 PCB on the left side and disconnect the cable (**2**) (white/pink) on the small backlight PCB.
9. Disconnect the yellow display cable (**1**)
10. Then untwist the mounting feet of the largest EMC shield. It is on the backside of the MK19 PCB. See Fig. 5.7

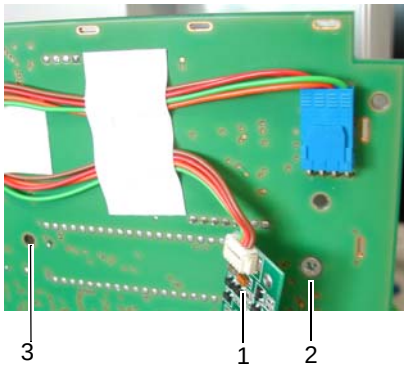


Fig. 6.21 Backside of MK19 and small backlight PCB

11. Remove the small backlight PCB (**1**). The mounting hole (**2**) behind it must be countersunk. The bolt head has to be on the same level as the PCB surface. Then fix the distance bolt by using a countersunk screw M2.5*8 (4.914020).
12. Fix the other three (**3**) distance bolts using the Philips-Screw 2.5*8 (4.910011).

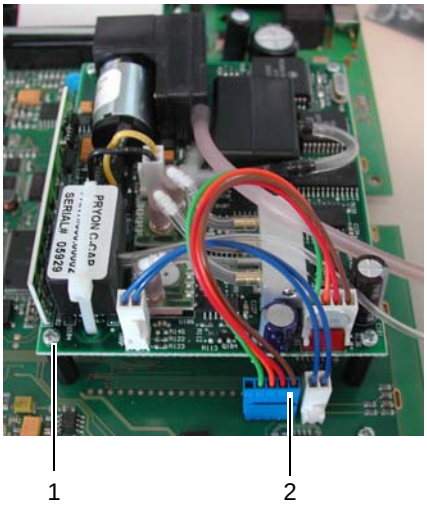


Fig. 6.22 Mounted LC101 module

13. Mount the LC101 module on the 4 bolts (**1**) using the 4 screws from the removed cover plate.
14. Connect the module to the LCM. 4 Pin connector for power & data (2) and 2 Pin Connector for micro switch (**2**). (4.520608 and 4.520495)
15. Set back the backlight PCB and reconnect the yellow display cable. Then put the EMC shield over the LC101 module and direct the tubes out of it. See illustration 11. Avoid any sharp bend. The thin, clear tube is the inlet and is connected to the watertrap receiver. The thick, pink tube is the gas outlet.
16. Put the large EMC shield over the LC101 module and fix it by twisting the mounting feet on the backside of the MK19. Fix the board MK19 (10screws) and transformer (4screws)
17. Fix the tubes. No squeeze, no sharp bend are accepted.
18. Connect the micro switch to the 2pin connector next to the transformer. See illustration 6. Then reconnect the ECG connector.
19. Double check all the cable and tube connections. If everything is connected properly, close the instrument (LCM) and fix the front with 6 screws from the backside.

Art. no.: 2.540033 rev.: d

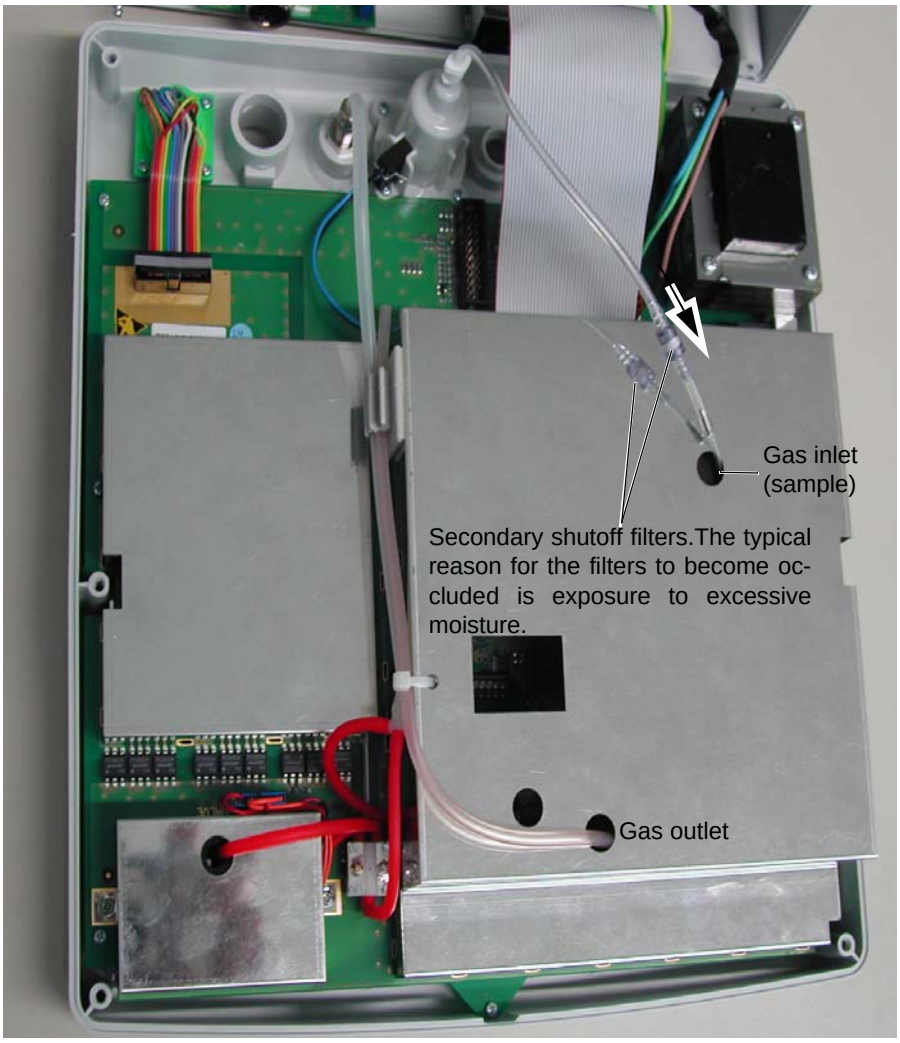


Fig. 6.23 Piping

6.3 Trouble shooting CO_2

Alarm/Messages	Cause	Remedy
Unable to calibrate	• CO_2 scrubber not attached • CO_2 scrubber expired. Pellets purple or turqoise	➜ Attached the CO_2 scrubber or replace it with a new one. ➜ Replace scrubber.
Time too long for calibration	• Defective CO_2 module	➜ Replace CO_2 module
CO_2 No watertrap	• Watertrap not connected • Microswitch failed	➜ Check connection of the watertrap ➜ Check microswitch
CO_2 module failure CO_2 menu not accessable	• CO_2 module failed • Lost connection • Power failure	➜ Replace device ➜ Check J101 ➜ Check power supply
CO_2 communication CO_2 menu not accesable	• Communication lost • CO_2 module failed • Lost connection • Power failure	➜ Replace device ➜ Check J101 ➜ Check power supply
CO_2 Environment dist	• Environment disturbed, wrong measuring of CO_2 concentration	➜ Check right assembly of watertrap or CO_2 absorber during calibration
CO_2 Occlusion	• Tube system clogged	➜ External *watertrap is blocked. Replace try again, or activate manually the switch in watertrap receiver. If still blocked. Internal secondary shut off (see page 73 and 78) needs to be replaced.
Calibrate CO_2	• Calibration interval expired	➜ Recalibrate CO_2 system. See calibration.

*The watertrap using time is dependant on the volume of the moisture. it is designed to hold up to 3.5 ml of moisture. So, depending on the application, the trap could last a couple hours or as many as 8-24 hours. There is nothing in the trap that will show how soon the trap must be replace. When the trap is full, the moisture eventually hits the shut-off pellet and occludes. Once occluded, the secondary shut off needs to be replaced must be replaced.

Alternative use a Sure CO_2 sample line (Nafion®) art number 2.100439. (See also page 73)

7 Various Installation and Replacements

7.1 Printer Installation

7.1.1 Scope of Supply

LCM UPGRADE KIT PRINTER SCHILLER ART 2.100750

Description:	Schiller art:	Quantity:
Printer	3.920907	1
Fixing bracket	4.415577	1
Step motor cable extension, 80mm *	4.520498	1
Ground cable	4.520611	1
Screw PT 30*10 (worm used for plastic)	4.910219	5
Counter sunk screw M3*6	4.914026	3
Counter sunk screw M3*10	4.914031	1
Nut M3	4.920003	1
Flat washer M3/3.2	4.930003	2
Serrated flat washer M3/3.2	4.930030	2
Register paper	2.157026	1

- Wire cutting pliers, small
- Metal file
- Knife universal
- Bevelled-edge chisel
- Screwdriver Philips No. 1, long shank (110 mm)
- Spanner 5.5 mm

Art. no.: 2.540033 rev.: d

7.1.2 Illustration catalogue

Fig. 7.1 Screw PT M3x10/4.910219

Fig. 7.2 Screw SK M3x6/4.914026

Fig. 7.3 Washers

Fig. 7.4 Motor cable extension 4.520498

Fig. 7.5 Ground cable 4.520611

Fig. 7.6 Registration paper 2.517026

Fig. 7.7 Fixing bracket 4.415577

Fig. 7.8 Thermal printer 3.920907

Fig. 7.9 Printer flap 4.310230

7.1.3 Mounting the printer into the fixing bracket

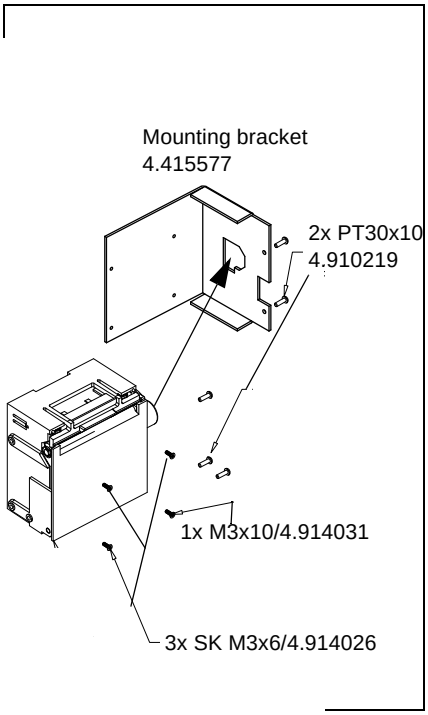
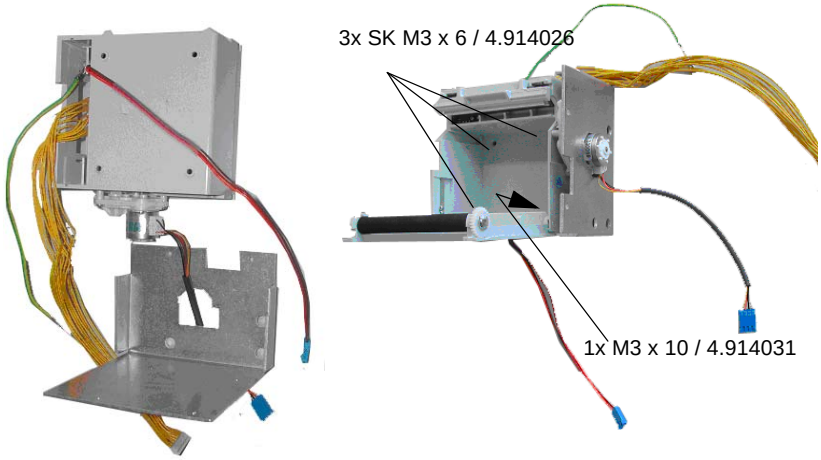


Fig. 7.10 Printer mounting on the fixing bracket

1. The step motor cable has to go through the hole of the fixing bracket.
2. Screw the printer onto the mounting bracket. The M3 x 10 screw takes place at the right lower corner
3. Lay the light barrier wires flat side by side (no space for crossing) on the backside of the printer. Can be fixed by a thin tape.



7.1.4 Opening the LCM

➜ To open the LCM, remove the 6 screws from the backside of the monitor and lay the front down carefully.

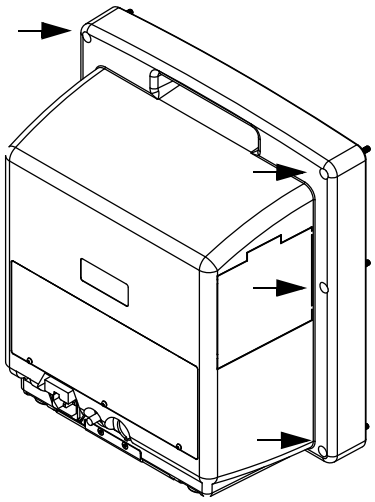


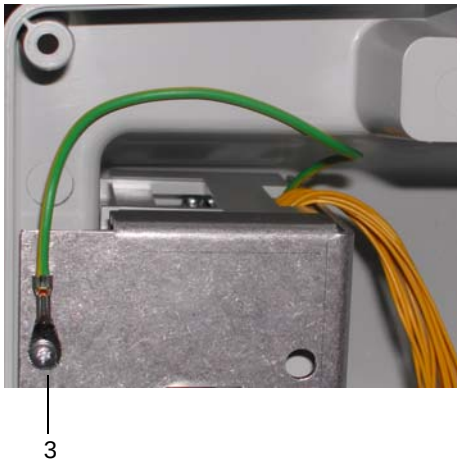
Fig. 7.11 Opening LCM

7.1.5 Removing printer faceplate and mount printer

Fig. 7.12 Removing printer cover

1. Cut the 4 fixation bridges (**1**) off at the inside of the LCM housing using the wire cutting pliers.
2. After that, carefully cut through the 4 bridges from outside of the housing using the bevelled-edge chisel or universal knife.
3. Removing the printer faceplate and file down the remaining parts.

4. Place the prepared printer as shown.
5. Mount the fixing bracket with 2 screws PT30*10.
6. Put the GND cable (**2**) of the thermal print head under the upper screw using a flat washer and a serrated flat washer (**3**). The serrated flat washer goes between the fixing bracket and the cable shoe and reduces the resistance. The flat washer goes between the cable shoe and the screw head.



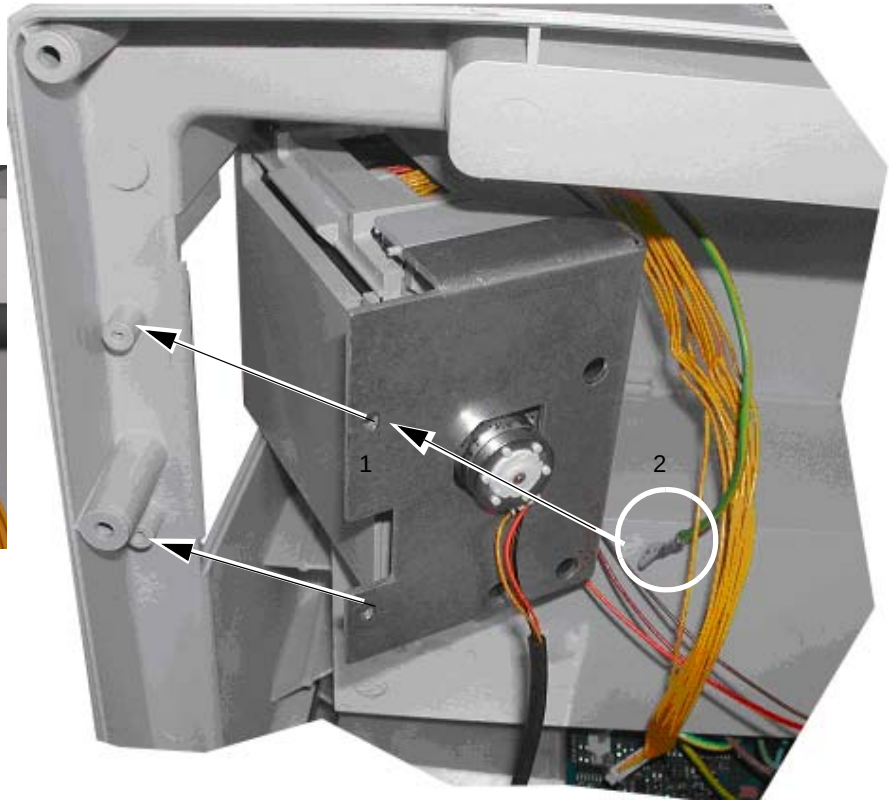


Fig. 7.13 Mounting printer

7. Take the long shank Philips screwdriver, put it through the fixing bracket hole and fix the other side of the printer using 3 screws PT 30*10.

Fig. 7.14 Fixing screw

8. Connect following cable on the PCB MK19-5:
   - Blue connector (**1**) 4 pins, step motor, if the motor cable is too short (150mm) use the cable extension cable (90mm).
   - Blue connector (**2**) 3 pins, light barrier
   - white connector (**3**) 13 pins, thermal print head
   - GND cable (**4**) to the mainboard MK19-1.

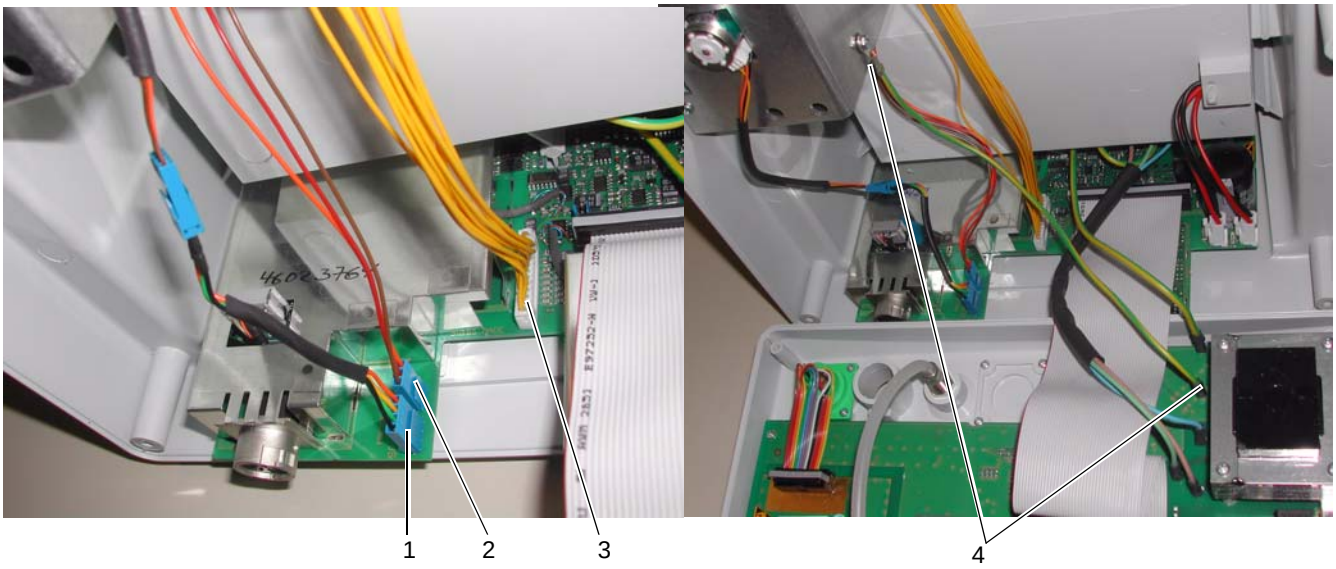


Fig. 7.15 Cable connections

9. The LCM can be reassembled. Check the proper placement of the PCB MK19-5. Close the LCM an fix it by 6 screws.
   Start the LCM, during start up the printer will be detected and ready for Printout unless paper is missing. See also paper load Illustration 11, paper load.
   If the LCM is in the specific state "Low Batt", printouts will be suppressed.

Art. no.: 2.540033 rev.: d

7.1.6 Paper load

➜ Load the registration paper [2.157026] as shown in the picture above. The paper has to be placed behind the printer flap. The black mark has to be on the left side. This mark is used to control the paper position. The paper grid looks upwards. Lift the paper end and close the printer flap.

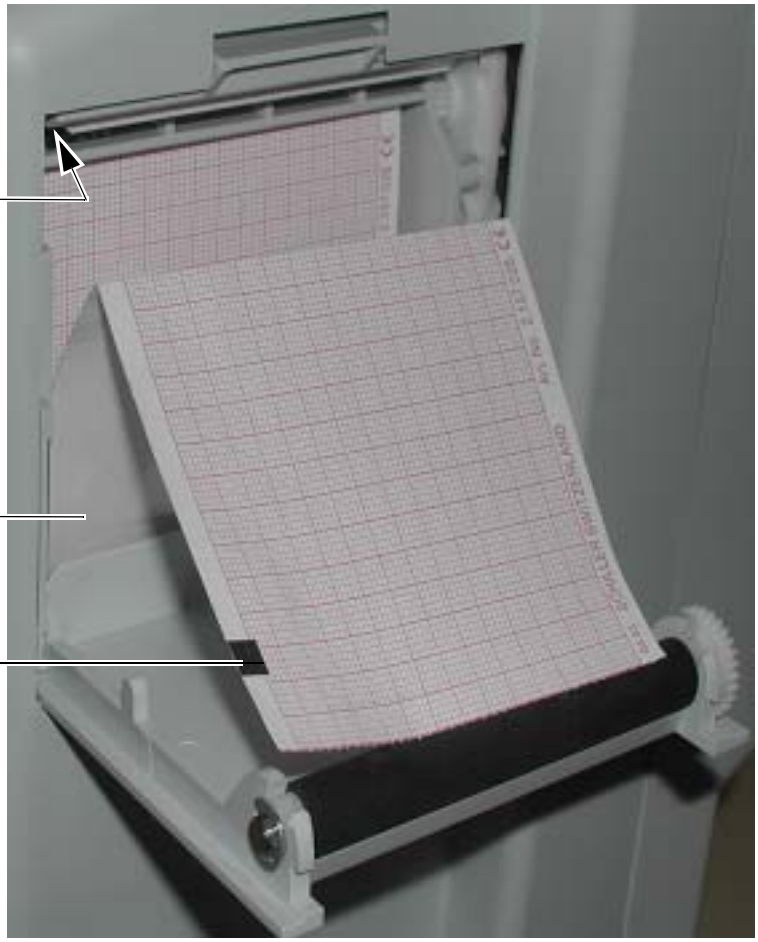


Fig. 7.16 Paper load

7.1.7 Drawings Printer

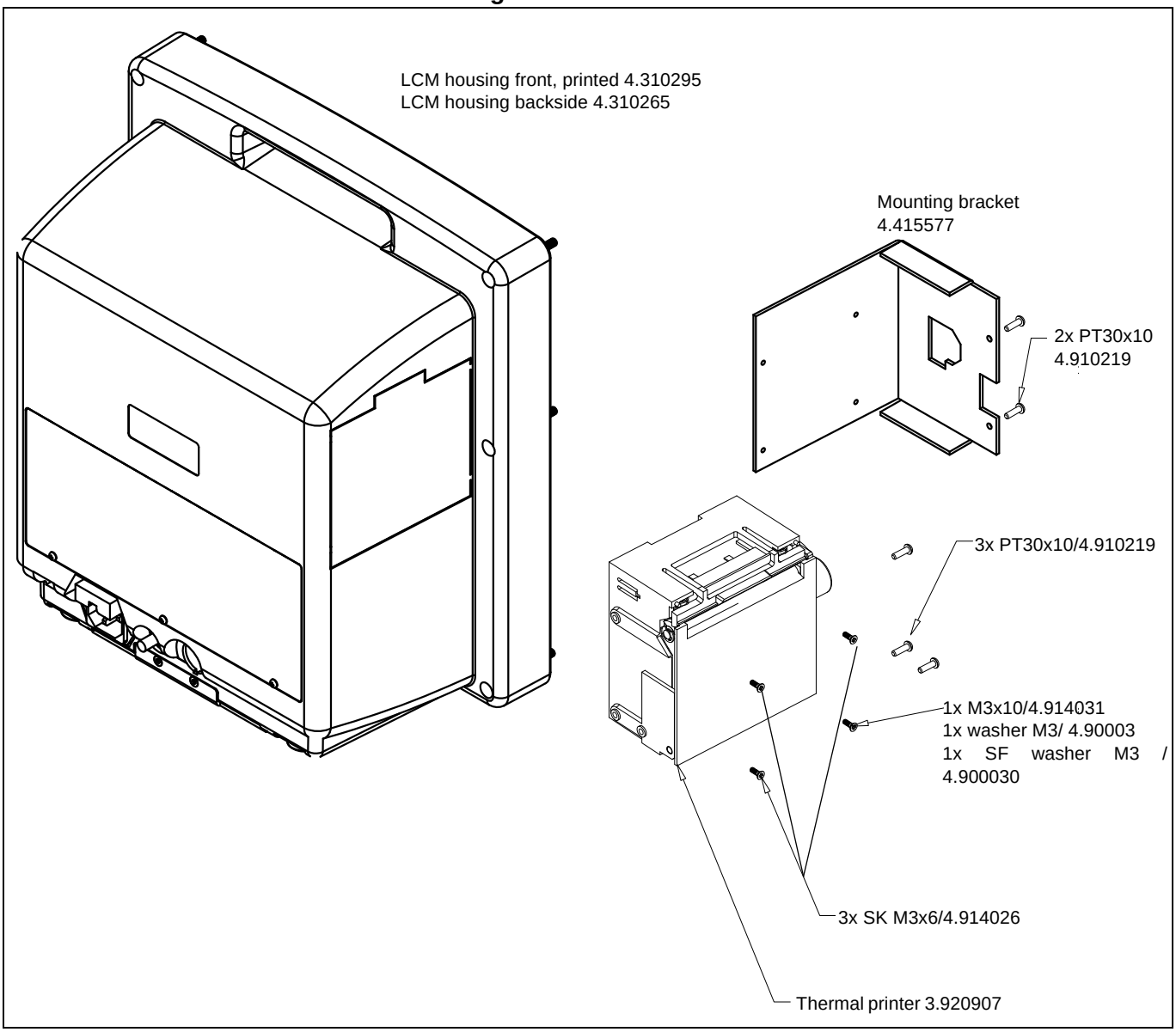


Fig. 7.17 Exploded drawing F.780043a

Flap and Drive roll

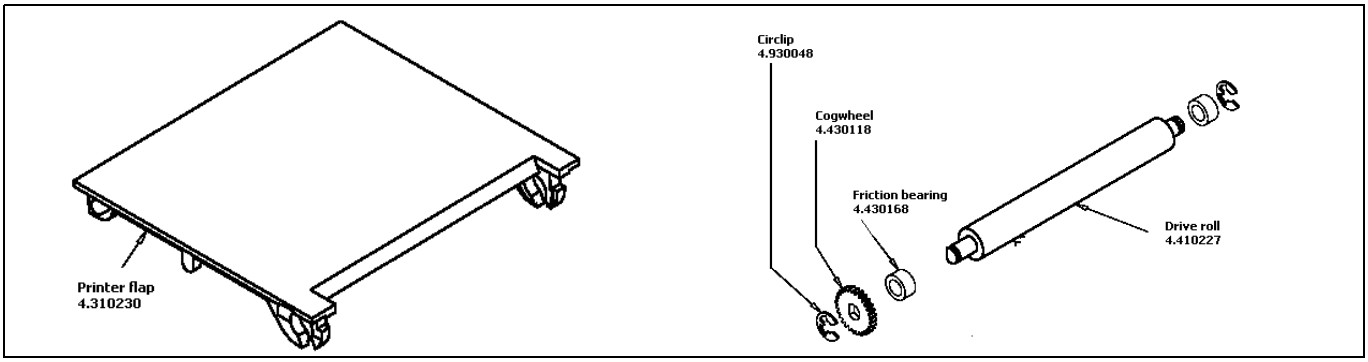


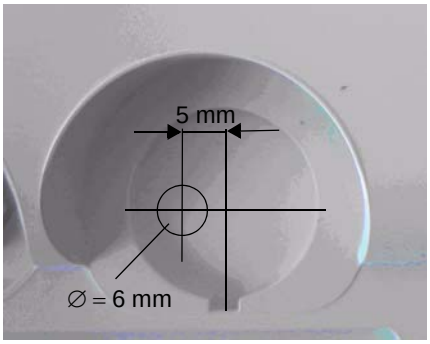
Fig. 7.18 Drawing flap and drive roll

7.2 Nurse call Installation

- For hardware requirements see page 12.
- This upgrade does not require a software update.
- Nurse call programming see page 29.

- Philips screw driver size 1, 2
- screw driver
- Flat pliers
- Soldering equipment
- Driller metal 6 mm
- Scale

7.2.1 Housing preparation



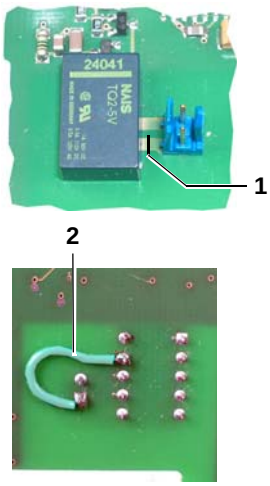
1. Remove the housing
2. Measure the distances according picture 8.1.
3. Drill a 6 mm hole
4. Mount the cable into the hole.
5. Continue version 1 or Version 2 nurse call.

Fig. 7.19 Cutout for nurse call

7.2.2 Version 1

➜ Plug in the cable 3.920903. Standard function is normally open (NO).
For the relays function normally closed (NC) proceed as follows:

1. Cut the strip line (1).
2. Solder a wire connection at the back of the relays (2)
3. Change the pinning of the nurse call cable (3) 3.920903.



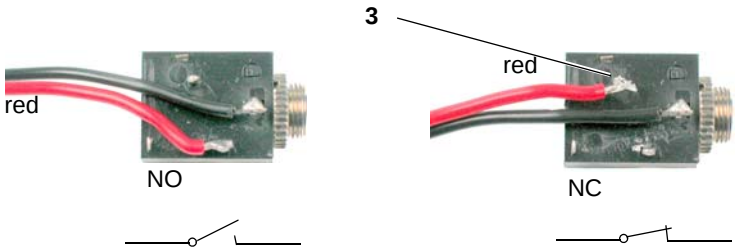


Fig. 7.20 Nurse call changes version 1

Art. no.: 2.540033 rev.: d

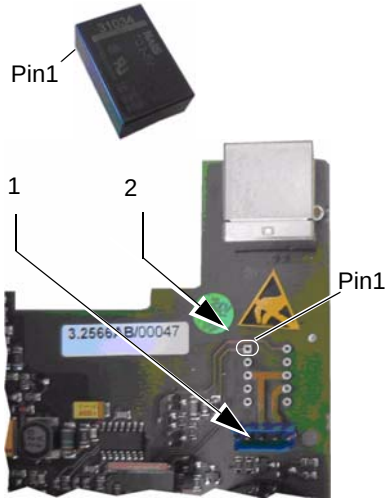


Fig. 7.21 Nurse call update version 2

Version 2

1. Solder in the nurse call relays (part. no.: 4.428006) to position 2.
2. Connect the cable on the board (1). (see also page 120 and 122)

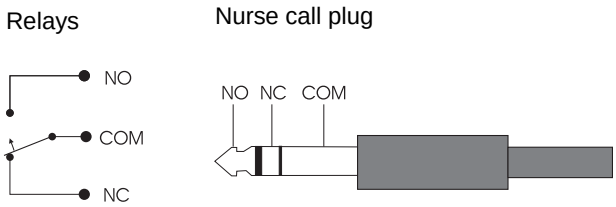
part. no.: 3.920908

Relays specification:

- TQ2-5
- 1A / 30 VDC
- 0.3 A / 110 VDC
- 0.5 A / 125 VAC

Nurse call plug connection

NC = normally closed
NO = normally open



7.3 NIBP Pump replacement

7.3.1 Rolling pump overview

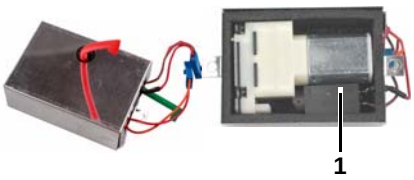
Pump V1 p/n 4.330040

- V1 pump excl. connecting cable p/n 4.330040
- Connecting cable p/n 4.520499
- 6 VDC, 1300 ccm, Samsung
- Coil resistance ≈ 10 Ω
- Current limitation on PCB 1 A with a 1 Ω resistance (R364II365)
- Typical inflation/deflation time @ 500 ml/ 250 mmHg
  0- 250 mmHg ≅ 19 sec
  250 - 0 mmHg ≅ 9 sec

Pump V2 p/n 3.920921

- V2 pump incl. connecting cable p/n 3.920921
  – V2 pump p/n 4.330045
  – Connecting cable p/n 4.520499
- 6 VDC, 1300 ccm, Mabuchi
- Coil resistance ≈ 6 Ω
- Current limitation on circuite board 1 A with a 1 Ω resistance (R364II365) or 1.3 A (R364II365II657)
- Typical inflation/deflation time @ 500 ml/ 250 mmHg
  0- 250 mmHg ≅ 15 sec
  250 - 0 mmHg ≅ 9 sec

Pump Set V2 p/n 3.920902



- Pump set V2 complete with pump, valve, tube and cable
- Protective rubber casing (1) p/n 4.435257

Pump V3 p/n 4.330044

- Pump V3 excl. cable p/n 4.330044
- Cable p/n 4.520650
- 6 VDC, 2300 ccm, Samsung
- Coil resistance ≈ 3.2 Ω
- Current limitation on PCB 1.3 A (R364II365III657)
- Typical inflation/deflation time @ 500 ml/ 250 mmHg
  0- 250 mmHg ≅ 10 sec
  250 - 0 mmHg ≅ 6 sec

Pump Set V3 “Service” p/n 3.920909

- Upgrade set incl. pump, valve, tube, cable mounting plate
- Protective rubber casing (2) p/n 4.435289

Pump Set V3 “Upgrade” p/n 2.100765

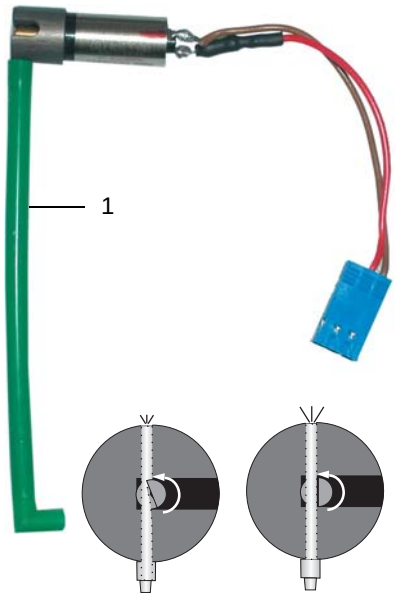
- Upgrade set incl. tube, cable mounting plate but without valve
- Valve **(2)** p/n 3.900432

Art. no.: 2.540033 rev.: d

7.3.2 Relieve valve

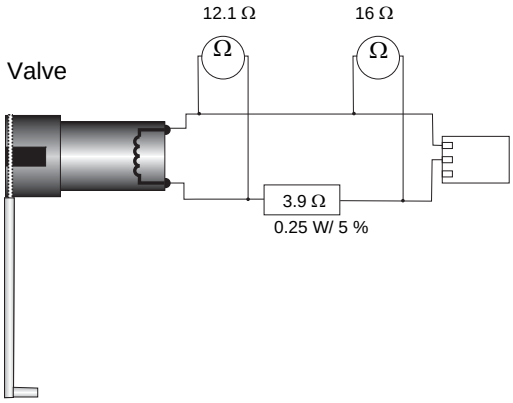
⚠ CAUTION

▲ Do never remove the silicone tube (1) from the valve. This can damage the valve.



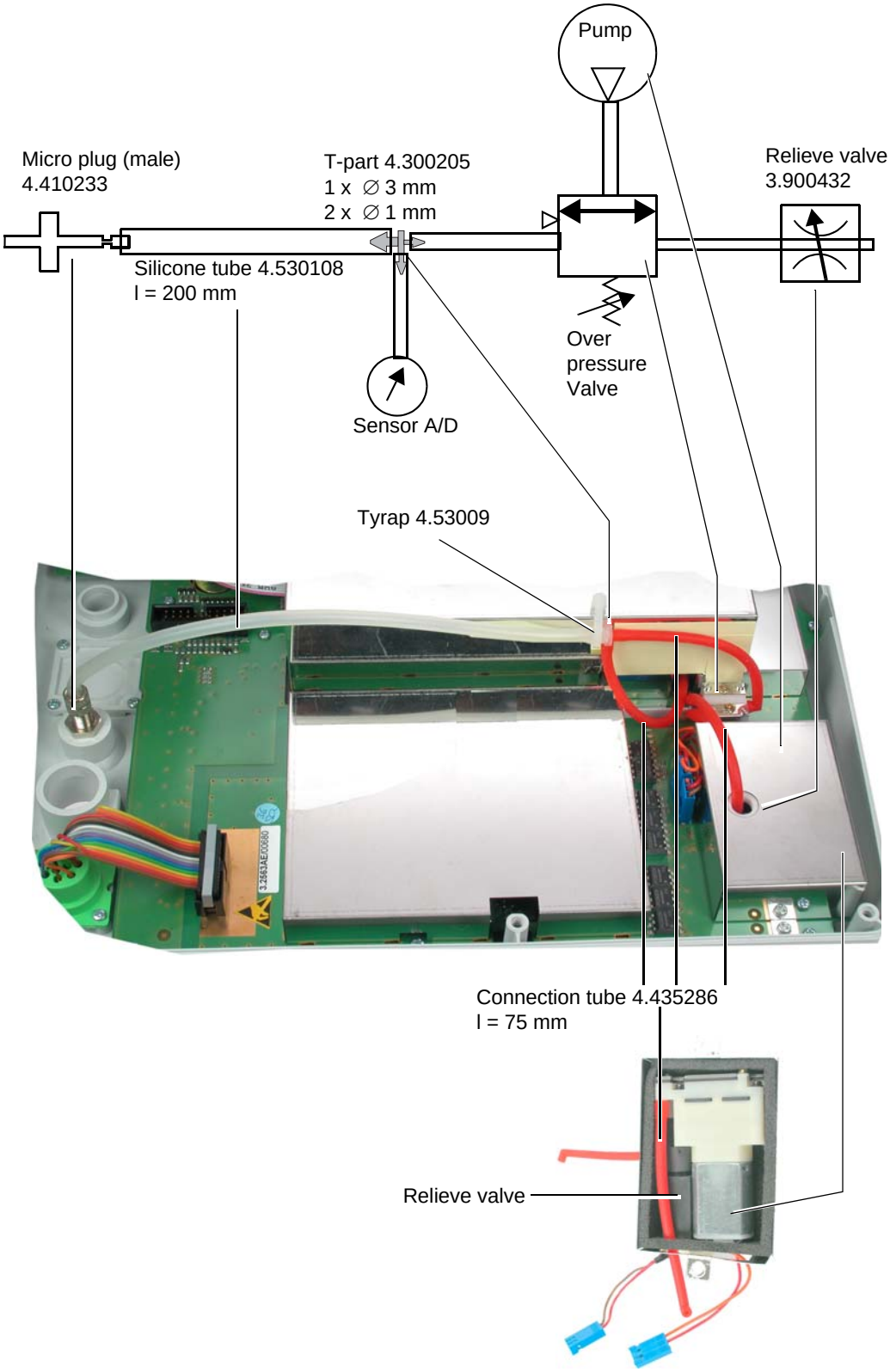
Relieve valve part. no 3.900432

Check the coil of the valve by measuring with a multimeter the resistance of the coil as shown in the drawing.



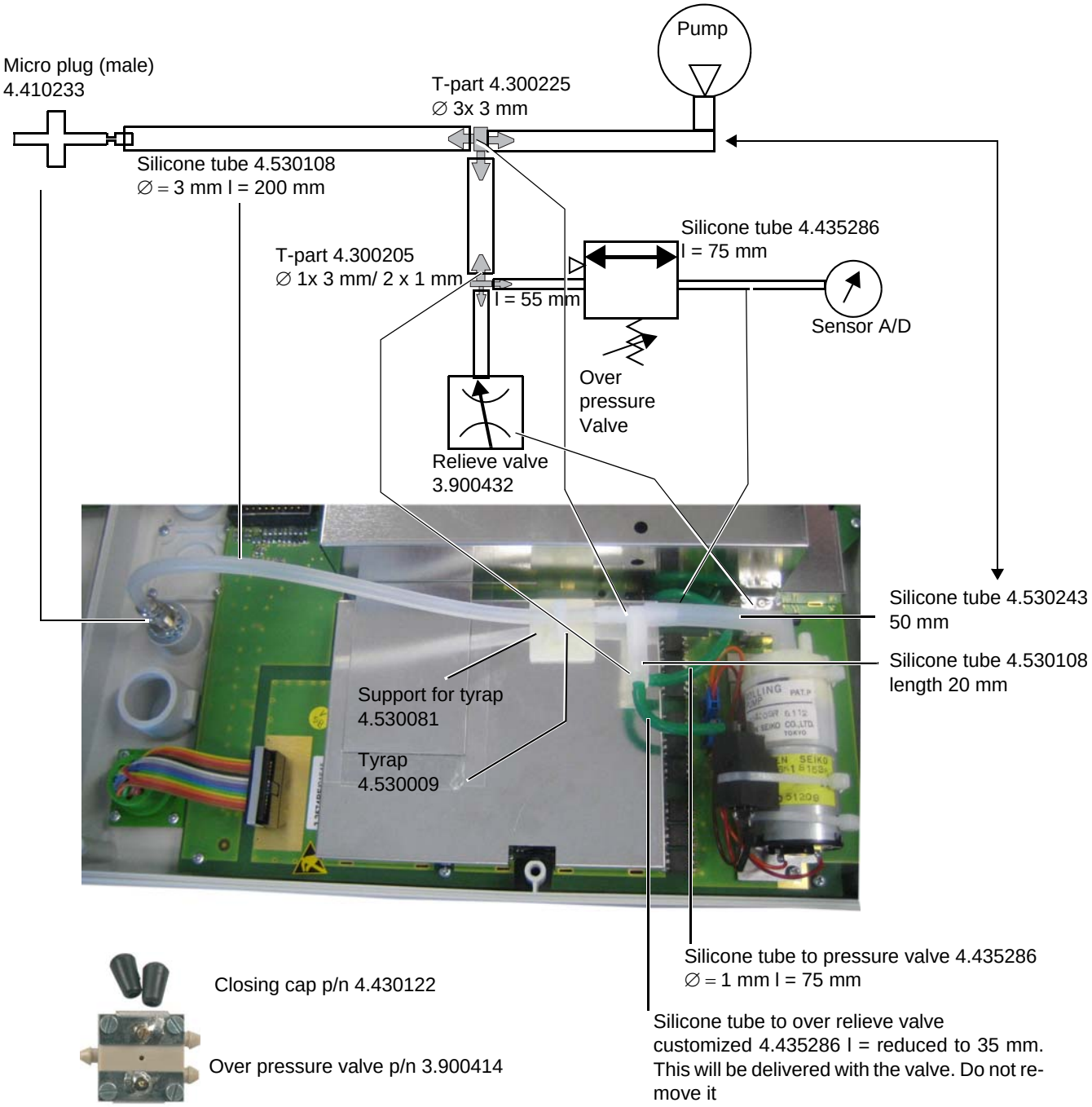
7.3.3 Rolling pump V1/V2 replacement

If V1 is replaced by V2 update current limitation



7.3.4 Rolling pump V3 replacement

See also drawing page 123



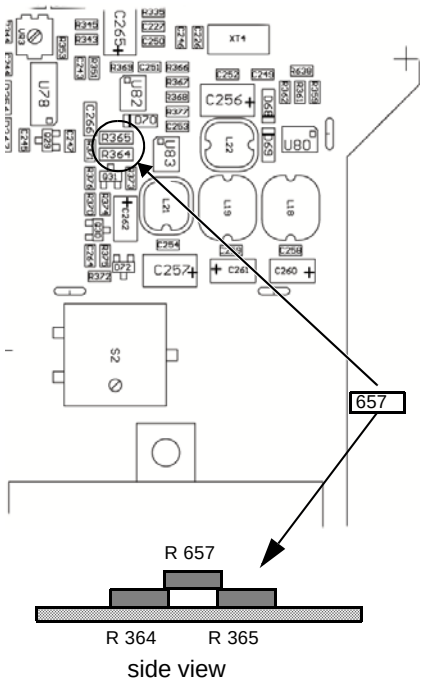
Art. no.: 2.540033 rev.: d

7.3.5 Update current limitation on the MK19-1 board

The Current limitation for the V2 and the V3 pump is 1.3 A.

If an V1 pump is replaced add a 1 Ω resistance (R657 Mini Melf 1Ω, 1%, 0204 p/n 4.716109) parallel to the resistance (R363II365).

Update necessary for index up to	Board index with current limitation 1.3 A
MK19-1/EU	MK19-1/EV and later
MK19-10/AE	MK19-10/AF and later
MK19-11/BD	MK19-11/BE and later



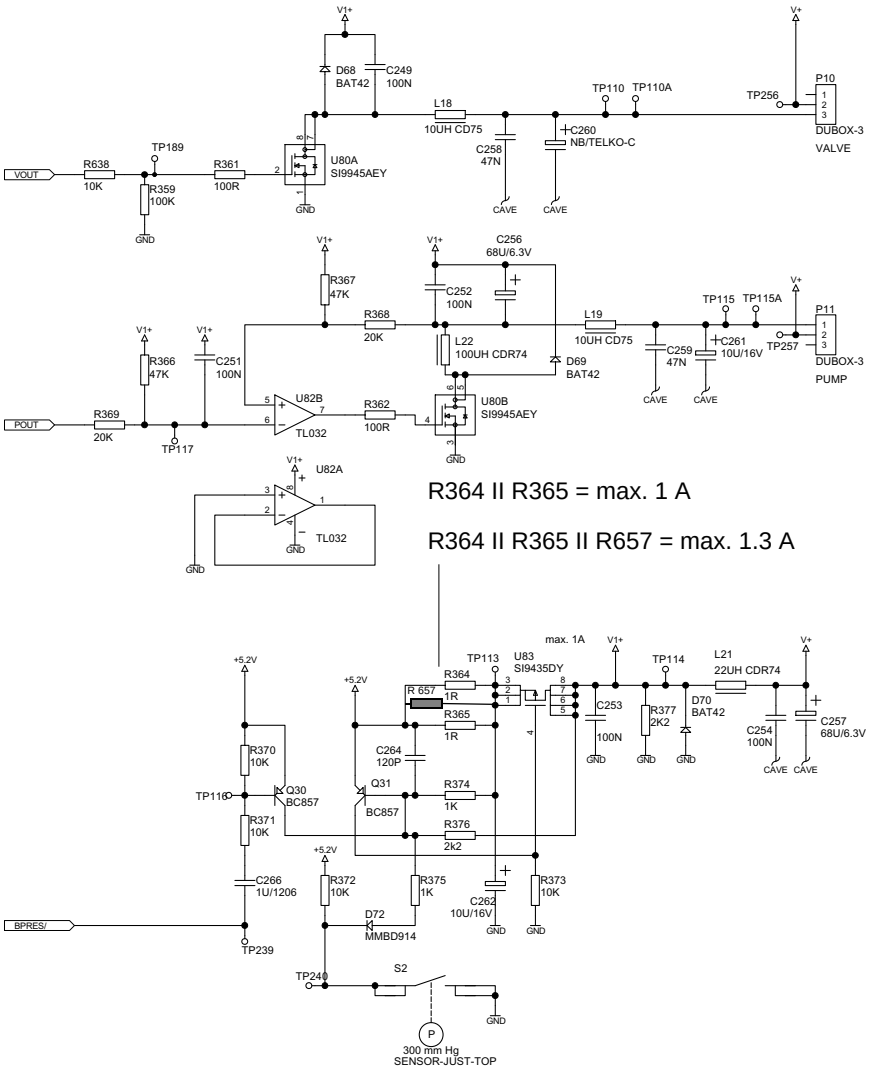
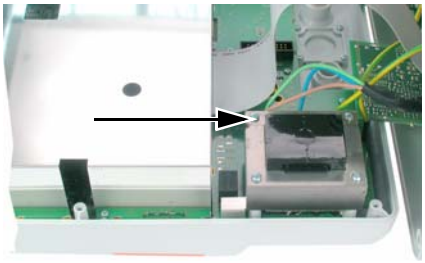


Fig. 7.22 Drawing MK19-1D sheet 13

7.4 Transformer replacement

Transformer V1 p/n 4.320066, 15 VA Intronic replaced by:

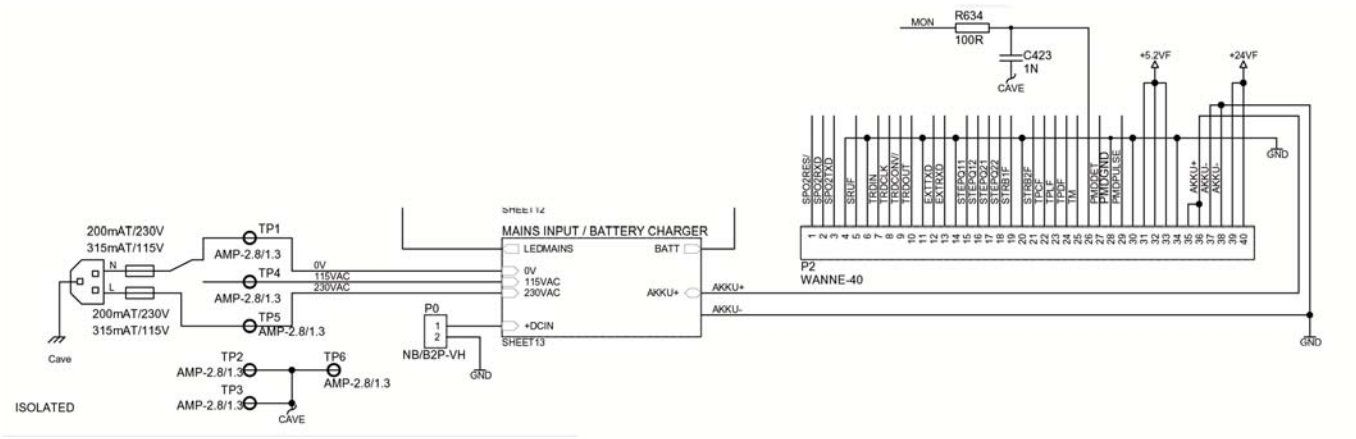


Transformer V2 p/n 4.320169 “Schaffer”

- 115/230 VAC, 50-60 Hz
- 25 VA
- Thermo fuse 130 °C
- Primary winding 115 V, I_N 0.254 A, Pin 1-3 = 39 Ω
- Primary winding 220 V, I_N 0.127A, Pin 1-4 = 152 Ω, Pin 3-4 = 113 Ω,
- Secondary winding Pin 5-6 = 1.3 Ω, U_N = 18.8 V, I_N 1.33 A

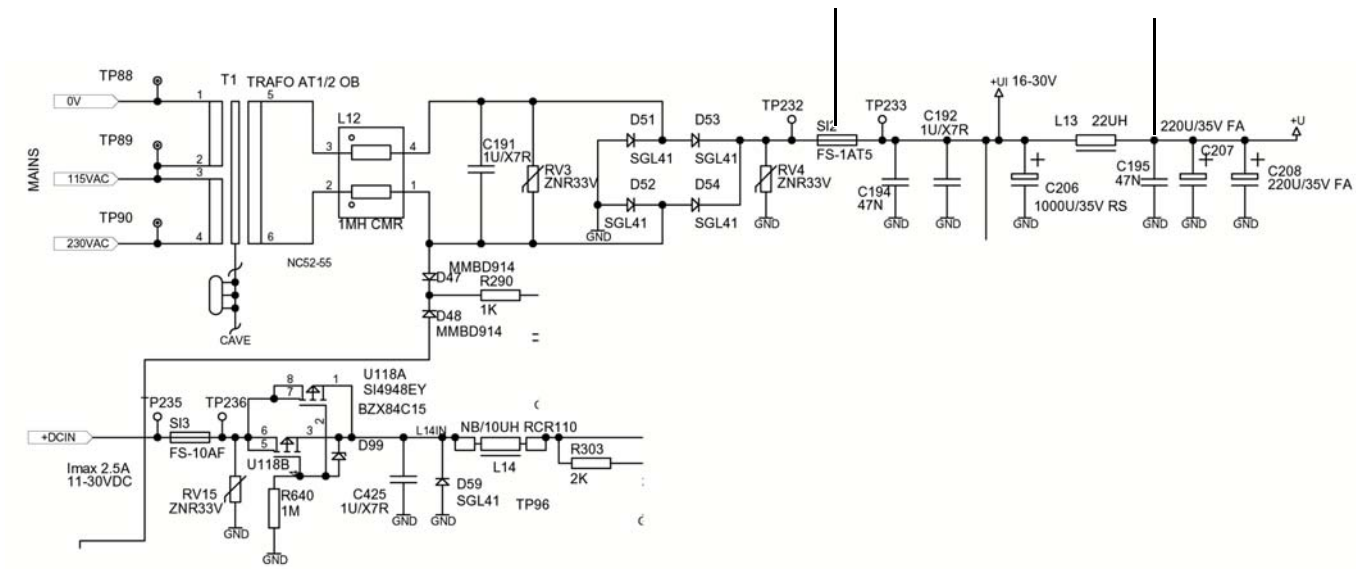
7.4.1 Transformer on the LCM print

See also drawing page 123 for component position



Fuse 1.5 AT p/n 4.215005

U ≈ 27 VDC



Art. no.: 2.540033 rev.: d

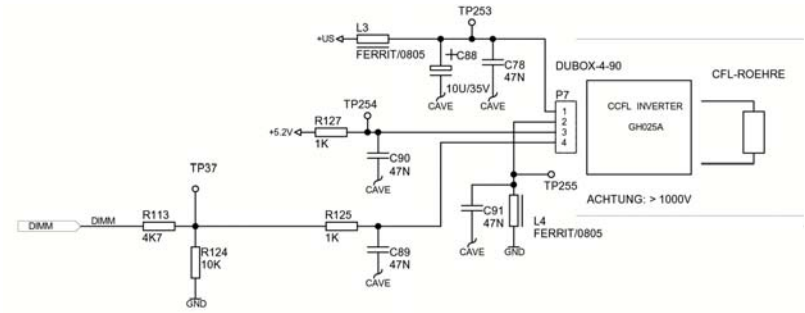
7.5 LCD Replacement

DANGER

▲ The backlight of the LCD has high voltage > 1000 V!

7.5.1 Backlight inverter V1 4.150114

Replaced by Version V2 p/n 4.150200 (see also page 12)

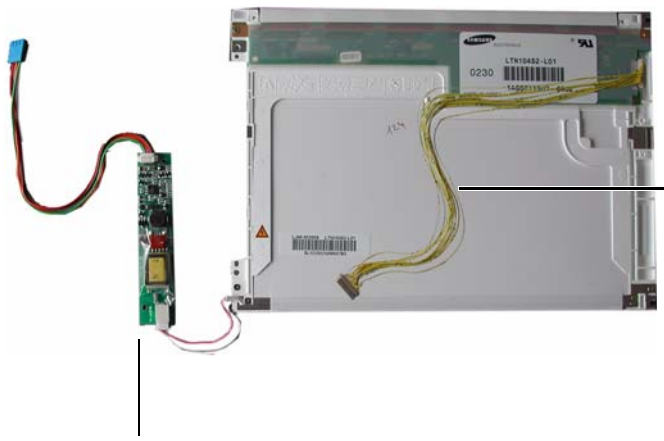


7.5.2 Overview LCD Version 1

See also drawing page 123 for cable position

LCD version 1 Samsung, 10,4 “ 800x600 pixel
p/n 4.600078

EMC shield for LCD
p/n 4.416104



14 pin cable
p/n 4.520600

Backlight inverter Version V1 p/n 4.150114

Pin assignment LCD version 1 with 14 pin connector

Pin No.:	Symbol	Function
1	VDD	Power supply + 3.3 V
2	VDD	Power supply + 3.3 V
3	GND	Ground
4	GND	Ground
5	RxIN0-	LVDS differential receiver channel 0
6	RxIN0+	
7	RxIN1-	LVDS differential receiver channel 1
8	RxIN1+	
9	RxIN2-	LVDS differential receiver channel 0
10	RxIN2+	
11	RxCLK-	LVDS differential receiver clock
12	RxCLK+	
13	GND	Ground
14	GND	Ground

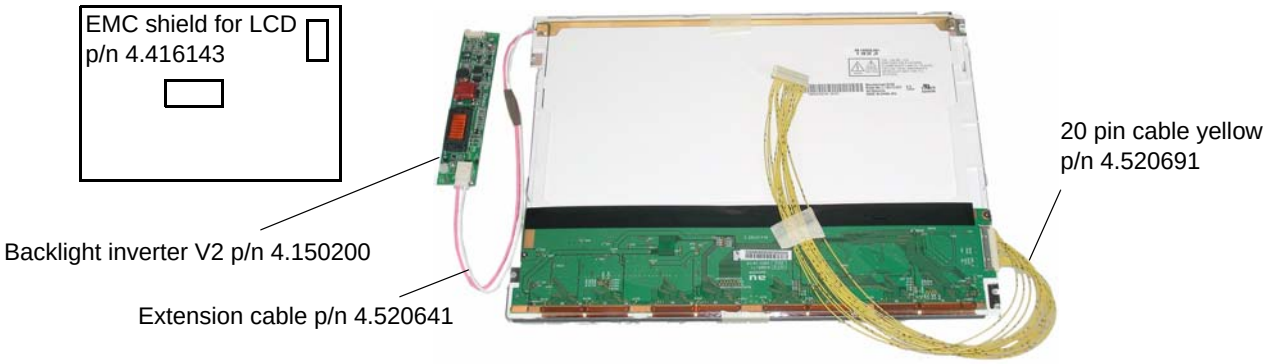
Backlight pin assignment

Pin No.:	Symbol	Colour	Function
1	Hot	pink	High voltage
2	Cold	white	Ground

7.5.3 Overview LCD Version 2

See also drawing page 123 for cable position

- LCD version 2 AU optronics p/n 3.910810 including:
  - LCD 10.4” 800x600 SVGA p/n 4.600085
  - Extension cable p/n 4.520641



Pin assignment LCD version 2 with 20 pin connector (backside of MK19-1x

Pin No.:	Symbol	Function
1	VDD	Power supply + 3.3 V
2	VDD	Power supply + 3.3 V
3	GND	Ground
4	GND	Ground
5	RxIN0-	LVDS differential receiver channel 0
6	RxIN0+	
7	GND	Ground
8	RxIN1-	LVDS differential receiver channel 1
9	RxIN1+	
10	GND	Ground
11	RxIN2-	LVDS differential receiver channel 0
12	RxIN2+	
13	GND	Ground
14	RxCLK-	LVDS differential receiver clock
15	RxCLK+	
16	GND	Ground
17	NC	No connection
18	NC	No connection
19	GND	Ground
20	GND	Ground

Backlight pin assignment

Pin No.:	Symbol	Colour	Function
1	H	pink	High voltage
2	L	white	Ground

Art. no.: 2.540033 rev.: d

8 Software Download

- Requirement to run Install.exe file:
  Win NT4, Win 98, Win 2000, Win XP.
- Connect the LCM to the mains
- Do not power off during update!

- RS-232 cable see drawing appendix.
- Download software Install_LCMVxxx.exe

8.1 Preparing serial communication

1. Connect the RS-232 cable to the connector (**1**) on the back of the device.
2. Connect the DB 9 connector to your PC RS-232 Com port.
3. Install the software on your pc with a double click to the Install_LCMV100.exe file.

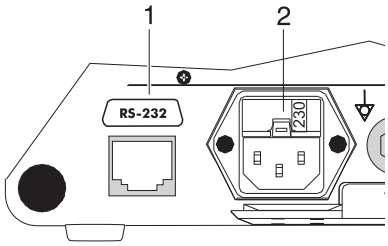
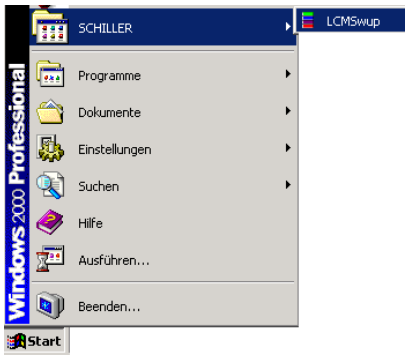


Fig. 8.1 RS-232 connector

4. Start the program LCMSwup
5. Press button config (**1**).
6. Select the com port (**2**) Com 1 or Com 2 you have choosen to download the software.
7. Select baudrate = auto.



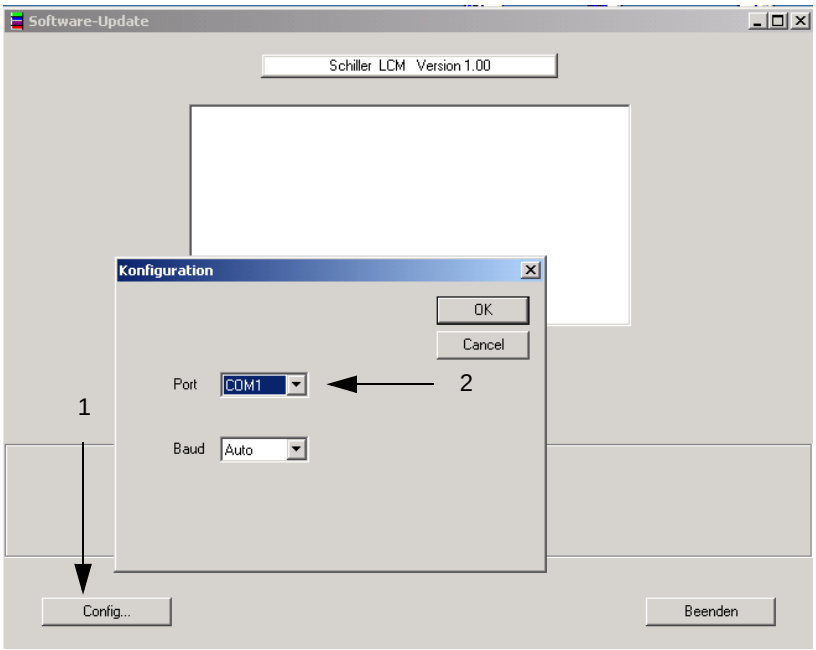


Fig. 8.2 Software update

Art. no.: 2.540033 rev.: d

8.2 Start Download

8.2.1 Program Update

- Updated the Software without updating the NIBP. NIBP module update will be done in the Service menu.
- Make sure the device is powered by mains.

1. Switch on the LCM.
2. Select the special menu option with following procedure:

   Press , select menu **About** press, and then .
3. The extended menu bar is displayed. Select now the menu software.

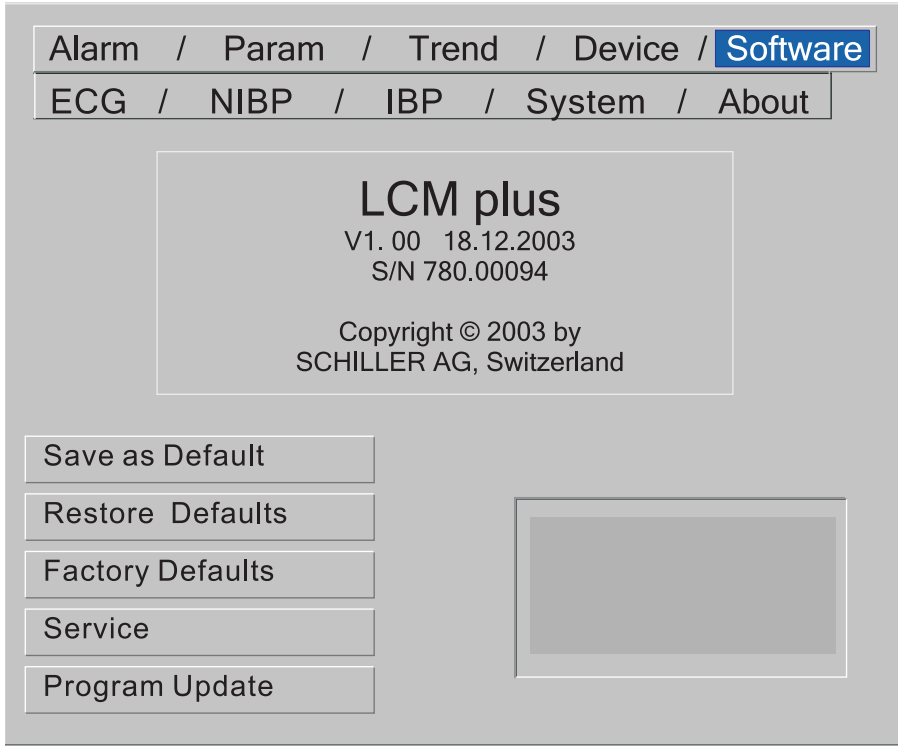


Fig. 8.3 LCM extended menu display

4. Press button Program Update.

Fig. 8.4 Program Update button

5. Press the button “Download” on the dialogue box of your PC.

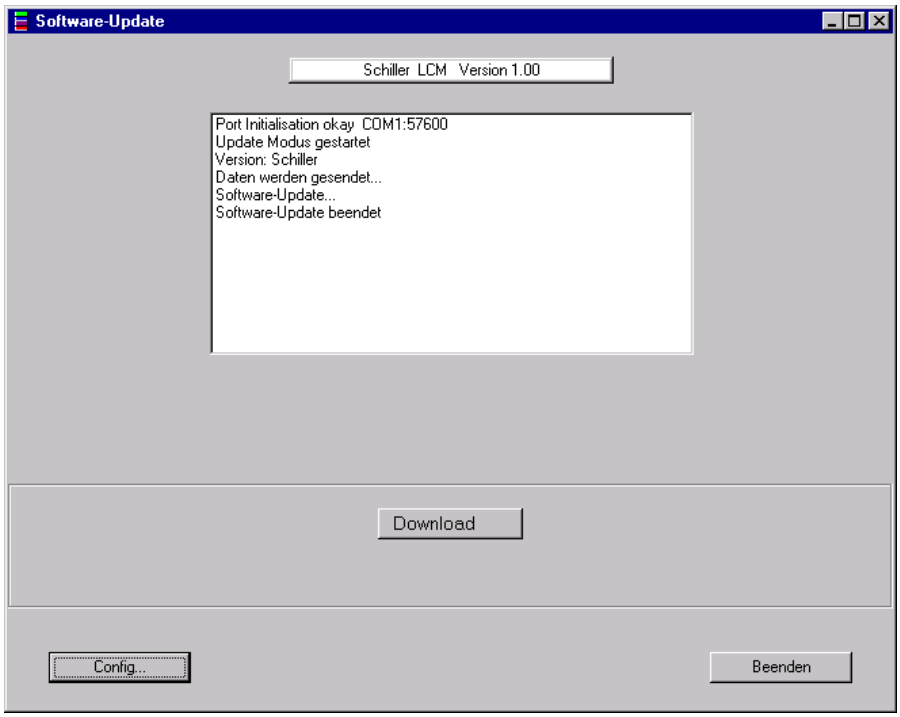
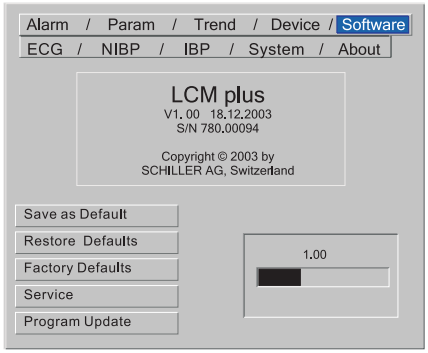


Fig. 8.5 Software dialogue box



6. The bargraph on the right side shows the progress of the download. After downloading, the device will restart automatically.
7. Check the Software version in the menu About.

8.2.2 NIBP Update

NIBP module can be updated after the Program Update (see chapter 8.2.1)

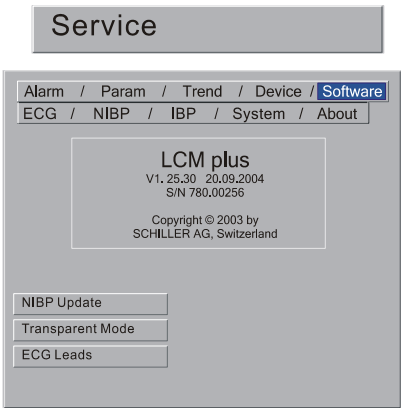


Fig. 8.6 Service menu

1. Go to the software menu. (see chapter 8.2.1)
1. Press button SERVICE.
2. Select button NIBP Update.
3. Press 4 x ENTER button to get access.

   If you want to abort the NIBP Update, press MENU button to leave the update menu.
4. Press again ENTER button to start update.

Do not power off during the update!

The LCM displays now the actual version, update version, the status and the transmitted blocs.

LCM plus
NIBP Software update
Actual Version: PB4.xx
Update to Version PB4.xx
Status: Bloc transfer/**Update finished**
Bloc: xxx of 513

5. Check Status on the screen.
   If the status is “Update finished” press menu button.
6. Restart the device.

LCM plus
V1.21 08.01.2004
S/N 780.00256
NIBP PB4.xx
SpO2 01 - 3.11- 2.00
C02 3000072020000 / 1.0

7. Go the about menu and check the NIBP software version.

Art. no.: 2.540033 rev.: d

9 Various Cables

9.1 RS-232 cable

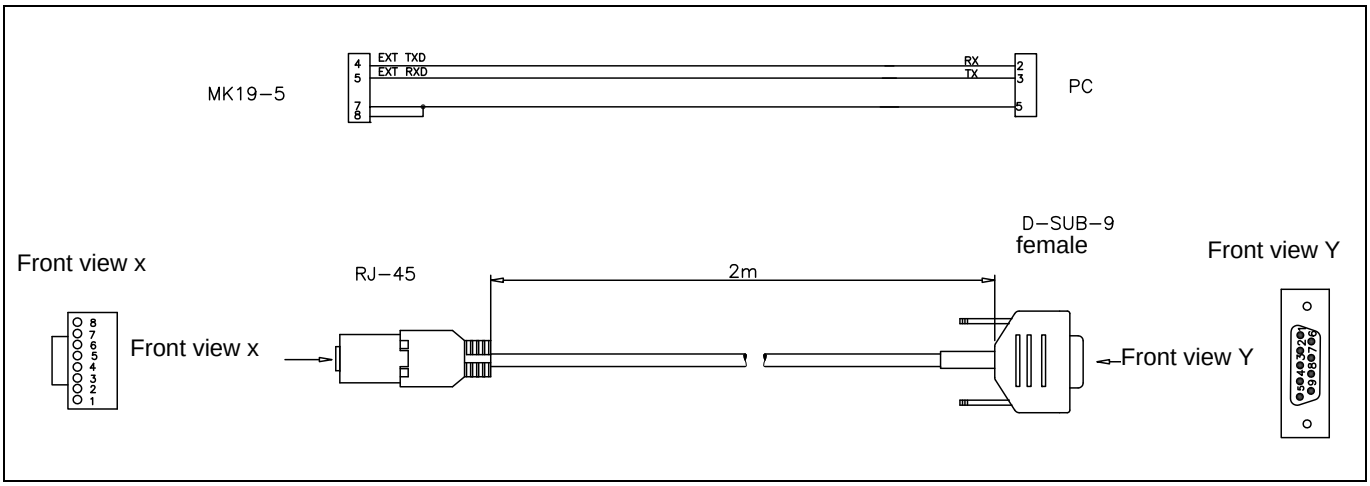


Fig. 9.1 Drawing RS-233 2.310208

9.2 Boardnet cable

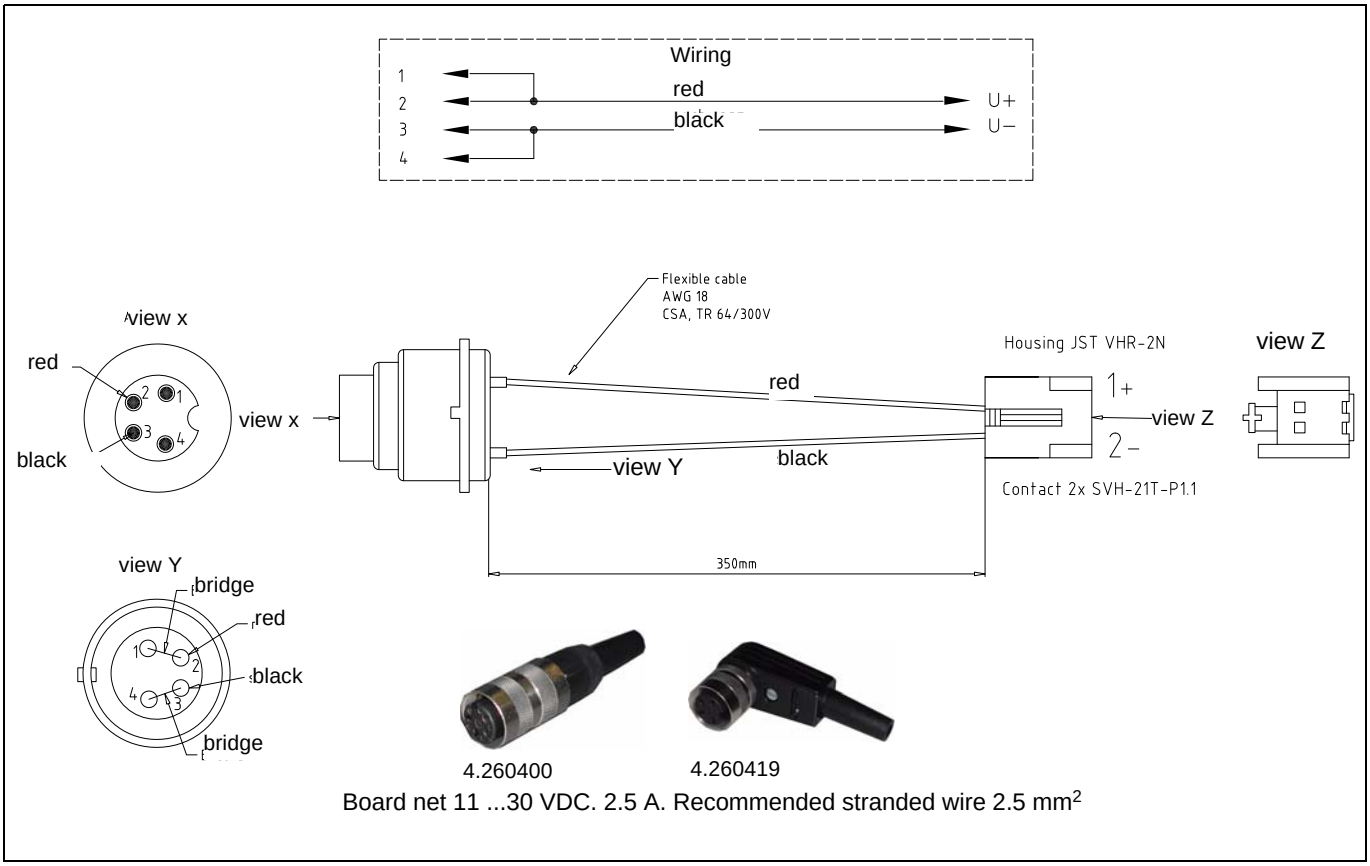


Fig. 9.2 Boardnet cable 4.520607

Art. no.: 2.540033 rev.: d

9.3 ECG cable

Device	Part. No.	Cable type	Lead/channel	Color	Protection	End
LCM	2.400041	Pat. Cable compl.	5-L	IEC	HF	Clip
LCM	2.400046	Pat. Cable compl.	5-L	AHA	HF	Clip
LCM	2.410065	Trunk cable	5-L	IEC	HF	Block
LCM	2.410067	Lead Set	5-L	AHA	HF	Clip
LCM	2.410068	Trunk cable	5-L	AHA	HF	Block
LCM	2.410148	Lead Set	5-L	AHA	STD	Banana
LCM	2.410158	Lead Set	5-L	AHA	STD	Snap
LCM basic	2.400009	Pat. Cable compl.	3-L *3P (RA-LA-LL)	IEC	STD	Clip
LCM basic	2.400207	Pat. Cable compl.	3-L *3P (RA-LA-LL)	IEC	HF	Clip
LCM basic	2.410042	Lead Set	3-L *3P (RA-LA-LL)	IEC	STD	Clip
LCM basic	2.410043	Trunk cable	3-L *3P (RA-LA-LL)	IEC	STD	Block
LCM basic	2.410049	Trunk cable (Neo)	3-L *3P (RA-LA-LL)	IEC	STD	Block
LCM basic	2.410075	Trunk cable	3-L *3P (RA-LA-LL)	AHA	HF	Block
LCM basic	2.410076	Lead Set	3-L *3P (RA-LA-LL)	AHA	HF	Snap
LCM basic	2.410331	Lead Set	3-L *3P (RA-LA-LL)	IEC	HF	Clip
LCM basic	2.410332	Trunk cable	3-L *3P (RA-LA-LL)	IEC	HF	Block
LCM plus	2.400039	Pat. Cable compl.	10-L	IEC	STD	Clip
LCM plus	2.400040	Pat. Cable compl.	3-CH	IEC	HF	Clip
LCM plus	2.400044	Pat. Cable compl.	10-L	AHA	STD	Snap
LCM plus	2.410064	Trunk cable	3-L (RL-RA-LA)	IEC	HF	Block
LCM plus	2.410066	Lead Set	3-L (RL-RA-LA)	AHA	HF	Clip
LCM plus	2.410149	Lead Set	3-L (RL-RA-LA)	AHA	STD	Banana
LCM plus	2.410159	Lead Set	5-L	AHA	STD	Snap
LCM plus	2.410161	Lead Set	5-L	IEC	STD	Clip
LCM plus	2.410162	Lead Set	5-L	IEC	STD	Clip
LCM plus	2.410310	Trunk cable (Neo)	3-L (RL-RA-LA)	AHA	STD	Block
LCM plus	2.410300	Trunk cable (Neo)	3-L (RL-RA-LA)	IEC	STD	Block

Example of the cable types:

Patient cable /complete

Trunk cable

Lead set

9.3.1 Cable type

Following general cables types:

This is common in EU

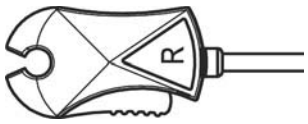


Fig. 9.3 Type Clip

This is common in US

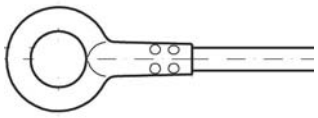


Fig. 9.4 Type Snap

Used only for veterinary

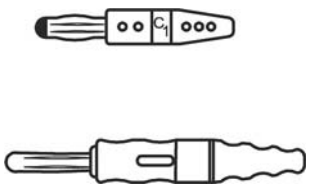


Fig. 9.5 Type banana

HF protected cable (low pass) are used in operation theatres to prevent from electro-surgery noises. Either cable or cable splitters are red marked.

The HF-protection is built in the main cable with a resitore of 10 KΩ and in the leads set (clip/snap) with a coil.

RRi monitoring is not possible using a HF ECG cable, because. the RRi measured signal is filtered by the HF protection cable.

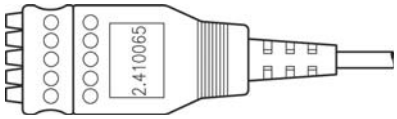


Fig. 9.6 Type HF-protection

9.3.2 ECG cable pinning

3-lead cable

Contact	3 lead IEC	Color	3 lead US	Color
*1	GND		GND	
2	30kΩ		30kΩ	
3				
4	R	RED	RA	WHITE
5				
6				
7				
8				
9				
10	N	BLACK	RL	GREEN
11				
12	L	YELLOW	LA	BLACK

3p-lead cable for monitoring ECG amplifier, LCM basic 781.>1000

Contact	3 lead IEC 3P	Color	3lead US 3P	Color
*1	GND		GND	
2	10kΩ		10kΩ	
3				
4	R	RED	RA	WHITE
5				
6				
7				
8				
9				
10				
11	L	YELLOW	LA	BLACK
12	F	GREEN	LL	RED

This cable is only for LCM basic SN. No.: 781.1000-xxxxx (see page 11)

*The resistor between 1 and 2 is for the cable detection

Art. no.: 2.540033 rev.: d

5-lead cable

Contact	5 lead IEC	Color	5 lead US	Color
*1	GND		GND	
2	82kΩ		82kΩ	
3				
4	R	RED	RA	WHITE
5				
6				
7				
8				
9	C	WHITE	V	BROWN
10	N	BLACK	RL	GREEN
11	L	YELLOW	LA	BLACK
12	F	GREEN	LL	RED

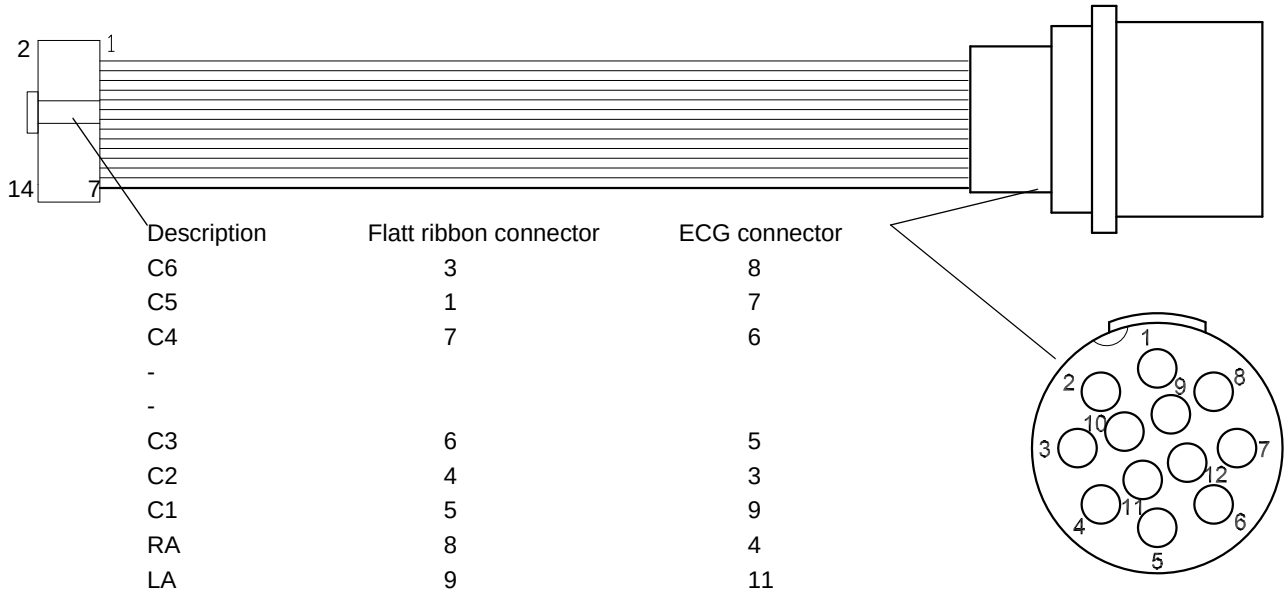
10 lead cable

Contact	10 lead IEC	Color	10 lead US	Color
*1	GND		GND	
2	180kΩ		180kΩ	
3	C2	YELLOW	V2	YELLOW
4	R	RED	RA	WHITE
5	C3	GREEN	V3	GREEN
6	C4	BROWN	V4	BLUE
7	C5	BLACK	V5	ORANGE
8	C6	VIOLET	V6	VIOLET
9	C1	RED	V1	BROWN
10	N	BLACK	RL	GREEN
11	L	YELLOW	LA	BLACK
12	F	GREEN	LL	RED

*The restistor between 1 and 2 is for the cable detection

Art. no.: 2.540033 rev.: d

9.3.3 ECG-cable connector to print

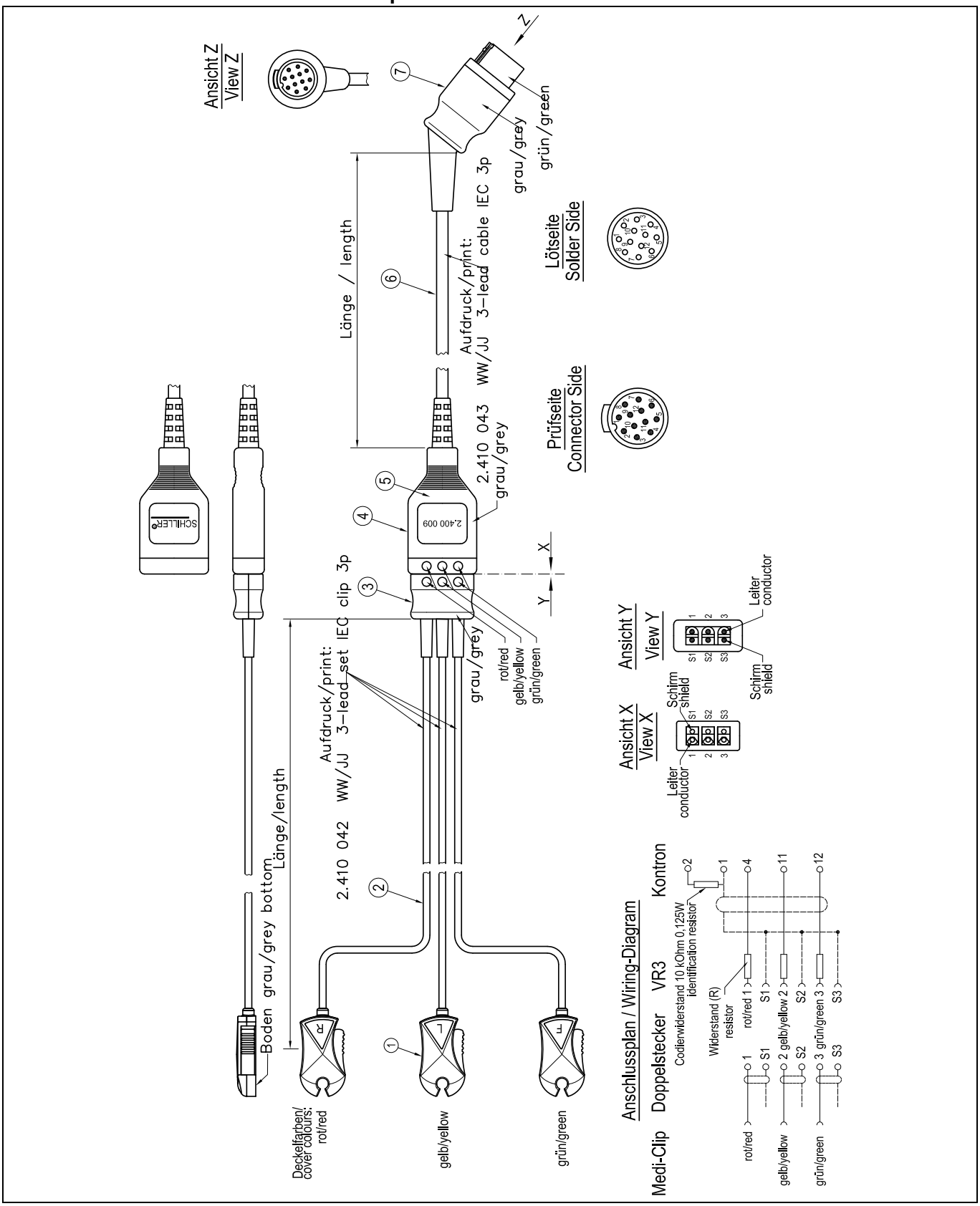


Description	Flatt ribbon connector	ECG connector
C6	3	8
C5	1	7
C4	7	6
-		
-		
C3	6	5
C2	4	3
C1	5	9
RA	8	4
LA	9	11
LL	10	12
RL	14	10
-		
AGNDi	13	-
KO	2	2
Screen	11/12	1

Fig. 9.7 Drawing ECG cable 4.520487

SCHILLER
ARGUS LCM/PLUS

9.3.4 ECG patient cable



Art. no.: 2.540033 rev.: d

Fig. 9.8 Drawing ECG patient cable 2.400009

9.4 SpO2 connection cable

Device	Parameter	Part No.	Product	Plug typ
LCM	SpO2	2.310212	Masimo	Lumberg
LCM	SpO2	2.310221	Nellcor	Lumberg
LCM	SpO2	2.310235	Masimo	Lumberg

9.4.1 SpO2 adapter cable

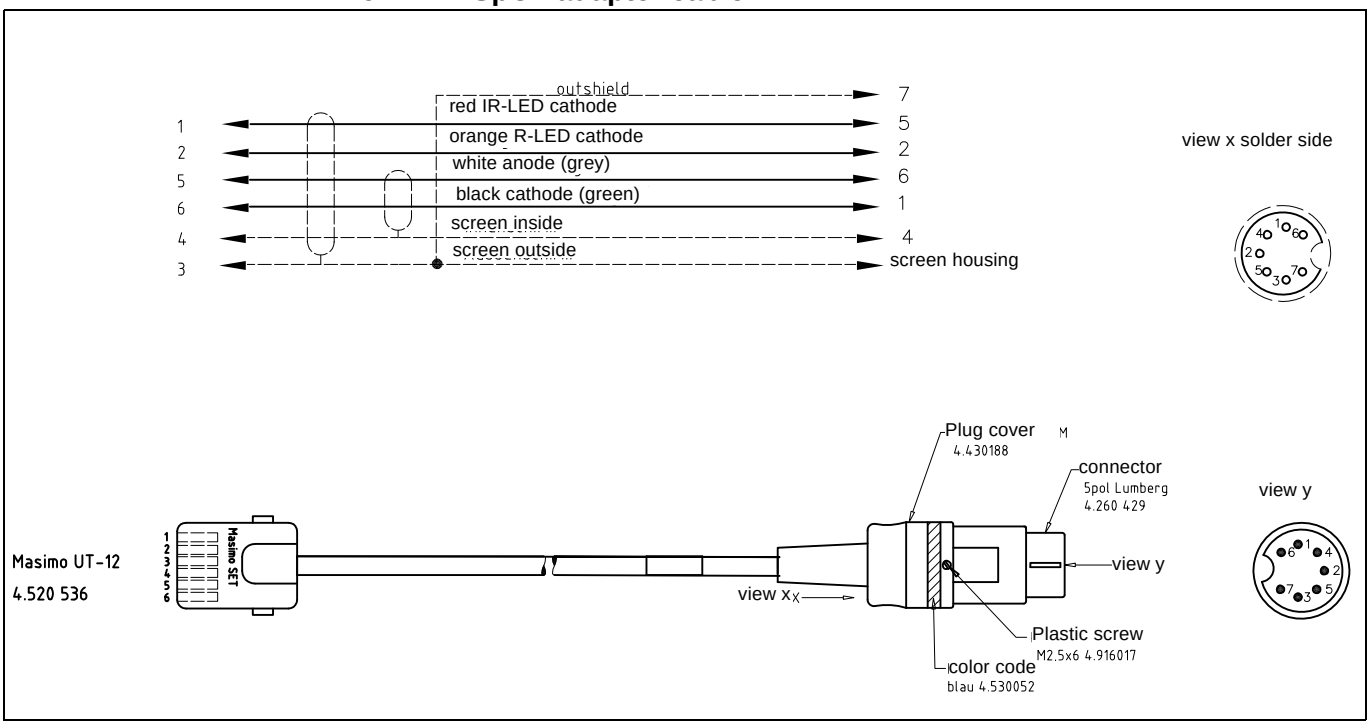
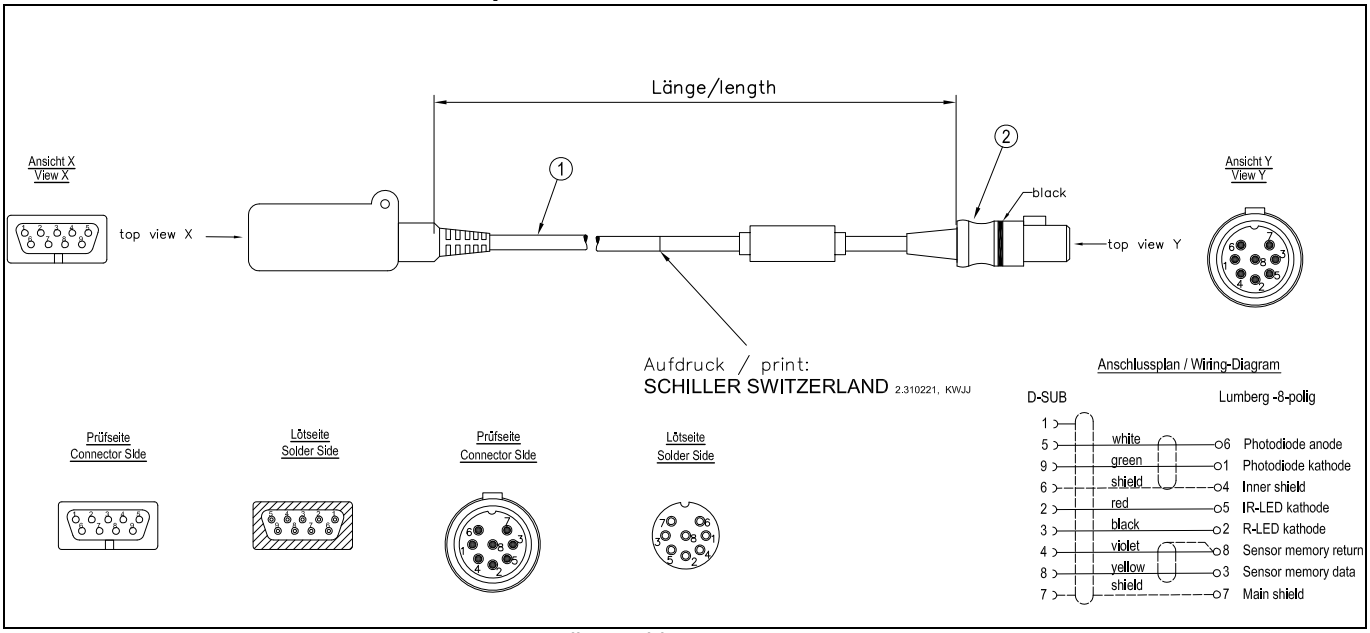


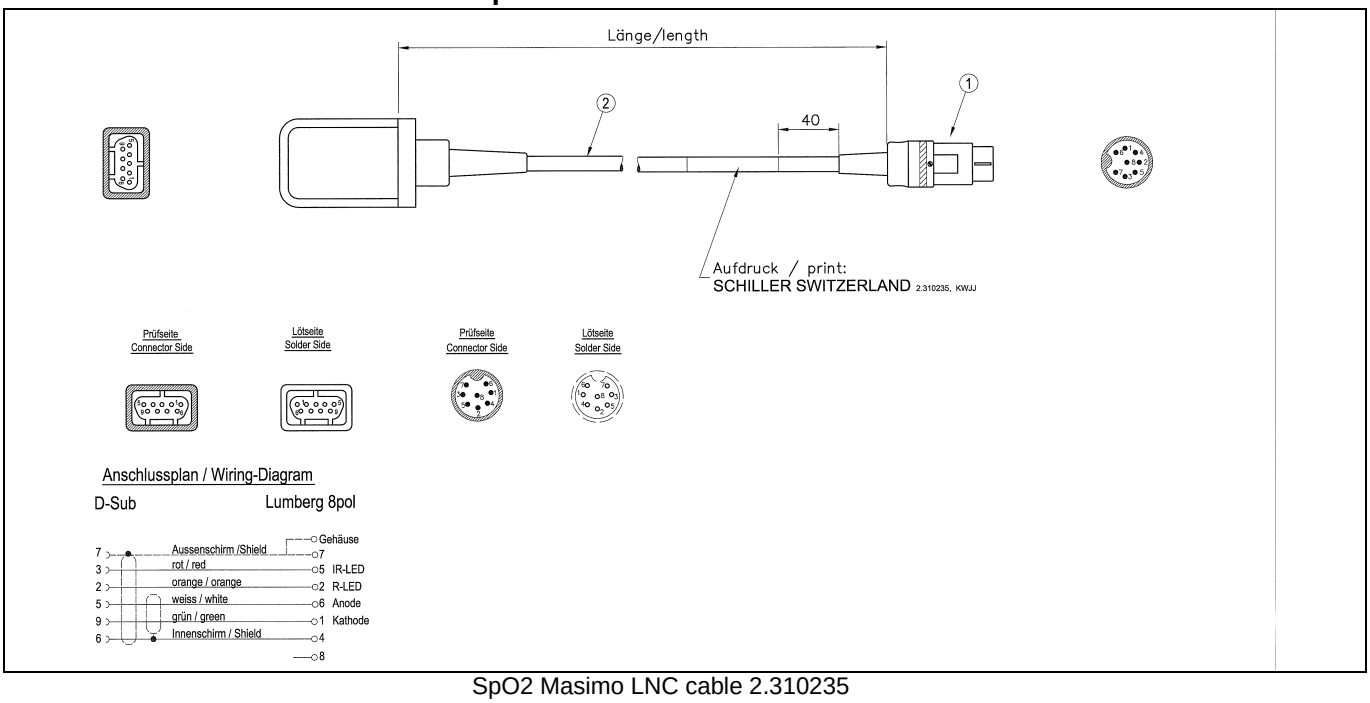
Fig. 9.9 $Sp0_2$ Adapter cable 2.310212

9.4.2 SpO2 Nellcor cable



SpO2 Nellcor cable 2.310221

9.4.3 SpO2 Masimo LNC cable



SpO2 Masimo LNC cable 2.310235

9.4.4 SpO2 LNCS Sensors

Picture	Part number	Description
	2.100578	LNCS PDTX SPO2 Fingersensor, Disp.,Pediatric <30 kg, box à 20
	2.100579	LNCS NeoPT SPO2 Fuss Sensor, Disp, Neonat. <10 kg., box à 20
	2.100580	LNCS INF-L SPO2 Fingersensor, Disp. Infant <30 kg, Box à 20
	2.100583	LNCS ADTX SPO2 Fingersensor, Disp. Erw. >30 kg, box à 20
	2.100581	LNCS Ped DCIP SPO2 Fingerclip, Pediatr.<30 kg, reusable
	2.100582	LNCS Adult TCI SPO2 Ohrsensor, reusable >30 kg

9.4.5 SpO2 LNOP Sensors

Pict	Part number	Description
	2.100408	Disposable Adult Digit Sensor Type LNOP ADT patients weighing >30kg/65lbs (box of 20 pcs)
	2.100409	Disposable Pediatric/Slender Digit Sensor Type LNOP PDT patients weighing 10-50kg/22-110lbs (box of 20 pcs)
	2.100410	Disposable Neonatal Sensor Type LNOP NEO patients weighing <10kg/22lbs (box of 20 pcs)
	2.100411	Disposable Neonatal Sensor Type LNOP NEO PT patients weighing <1kg/2.2lbs (box of 20 pcs)
	2.100303	Reusable Adult Finger Sensor Type LNOP DCI patients weighing >30kg/65lbs
	2.100305	Reusable Pediatric Finger Sensor Type LNOP DCIP patients weighing 10-50kg/22-110lbs
	2.100417	Reusable SpO2 Sensor LNOP/YI standard petite wrap, >1 kg <30 kg
	2.100415	Reusable ear sensor, adult LNOP TC-I Type Clip >30 kg
	2.140418	Universal YI clean shield wrap, pkg of 100
	2.100419	YI multisite wrap for adults, pkg of 100
	2.100420	YI petit wrap for neonates and pediatrics, pkg of 100

9.4.6 SpO2 Nellcor Sensors

Picture	Part number	Description
	2.100385	Reusable adult Finger Sensor Type DS-100A patients weighing >40 kg
	2.100386	Reusable multisite Sensor Type DS-YS patients weighing >1 kg
	2.100388	Reusable adult/neonatal Sensor Type OXI-A/N patients weighing >3 kg or 40 kg
	2.100389	Reusable pediatric/neonatal Sensor Type OXI-P/I patients weighing 3 - 40 kg
	2.100405	Reusable pediatric spot checkSensor Type D-YSPD patients weighing 3 - 40 kg
	2.100407	Reusable ear clip Type D-YSE patients weighing >30 kg 8 (use with 2.100386 DS-YS)

Art. no.: 2.540033 rev.: d

9.5 IBP connection cable

Picture	Device	Parameter	Part No.	Product	Plug type
	LCM	IBP	2.310029	Ohmeda, B&D	Lumberg
	LCM	IBP	2.310045	Utah	Lumberg
	LCM	IBP	2.310103	Braun	Lumberg
	LCM	IBP	2.310117	Transpac IV	Lumberg
	LCM	IBP	2.310118	Baxter	Lumberg
	LCM	IBP	2.310127	x-trans	Lumberg
	LCM	IBP	2.310236	PVB	Lumberg
	LCM	IBP	2.310011	Mediserve (CM-8)	Lumberg

SCHILLER
ARGUS LCM/PLUS

9.5.1 Cable IBP Braun

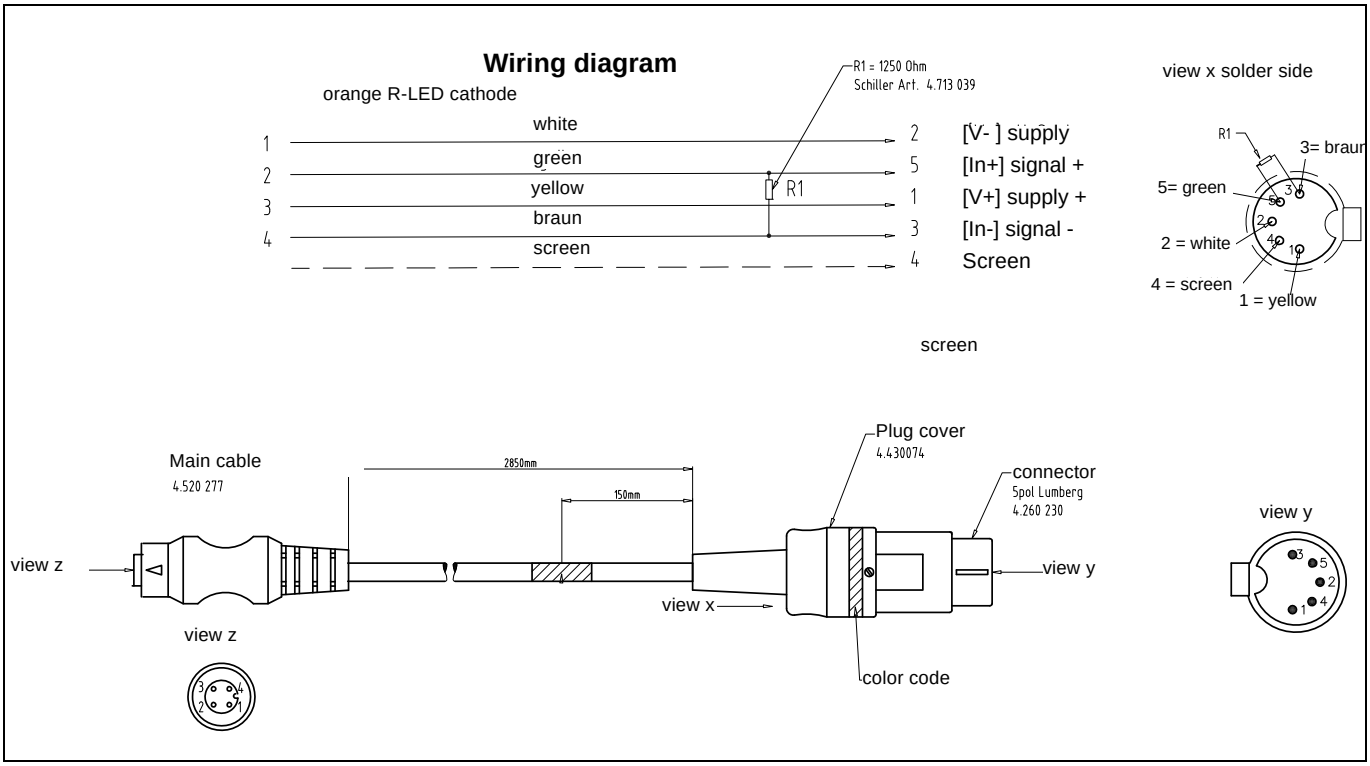


Fig. 9.10 IBP Braun cable 2.310103c

Art. no.: 2.540033 rev.: d

9.5.2 Testbox cables

IBP cable

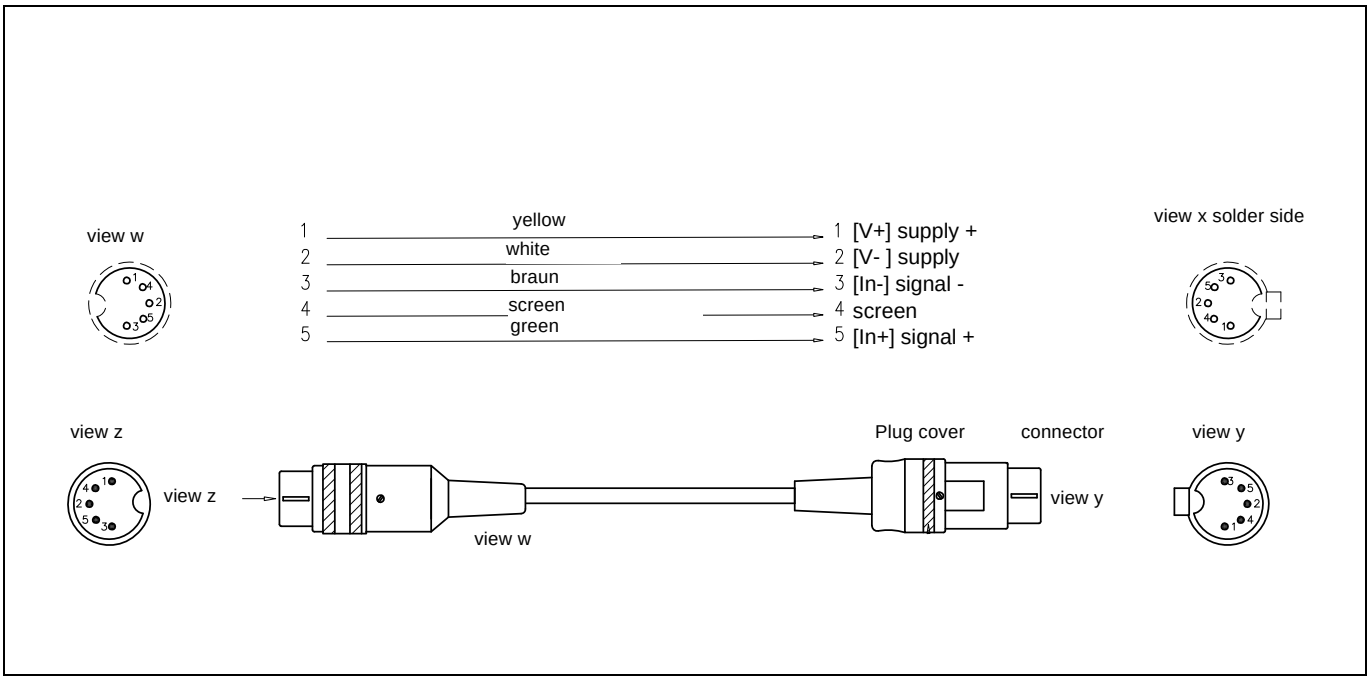


Fig. 9.11 IBP text box cable 4.520677

9.6 Temperature probe

Device	Parameter	Part No.	Product	Type
LCM	Temp	2.100330	Oesophagal	YSI 401
LCM	Temp	2.100331	Skin	YSI 409
LCM	Temp	2.100332	Oesophagal rectal neon.	YSI 402
LCM	Temp	2.100334	Ear	D-TM1 JK

9.6.1 Temperature cable

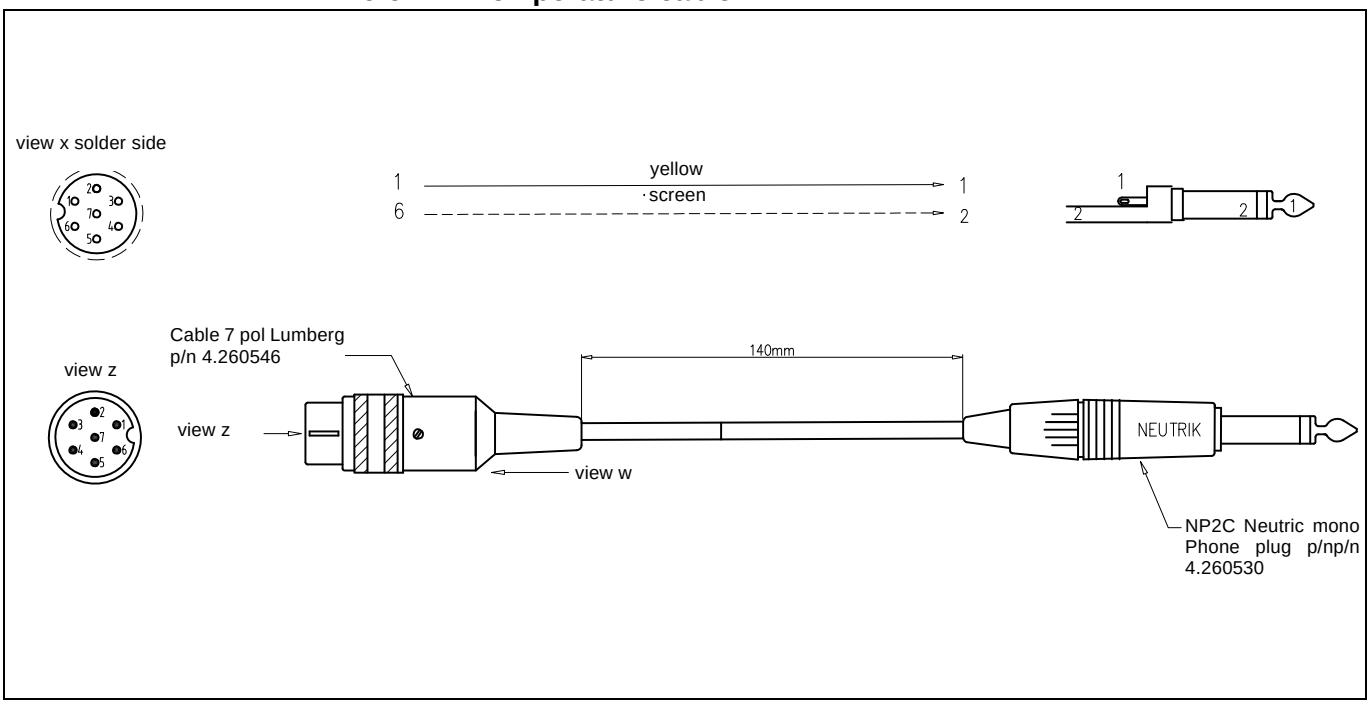
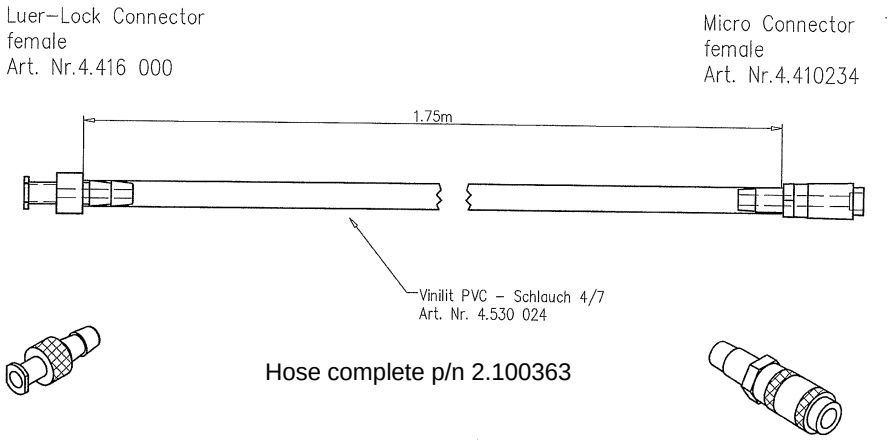


Fig. 9.12 Temperature test box cable 4.520678

9.7 NIBP Cuff and connection hose

Cuff with Luer lock- micro connector

Part No.	Product
2.120008	Cuff Neonatal small, 4.3-6.4 cm/1.7-2.5 in. (set of 10)
2.120009	Cuff Neonatal medium, 5.9-8.7 cm/2.3-3.4 in. (set of 10)
2.120010	Cuff Neonatal large, 7.2-10.7 cm/2.8-4.2 in. (set of 10)
2.120011	Cuff Neonatal x-large, 8.5-12.7 cm/3.3-5 in. (set of 10)
2.120012	Cuff Neonatal Infant, 9.6-14.3 cm/3.8-5.6 in. (set of 10)

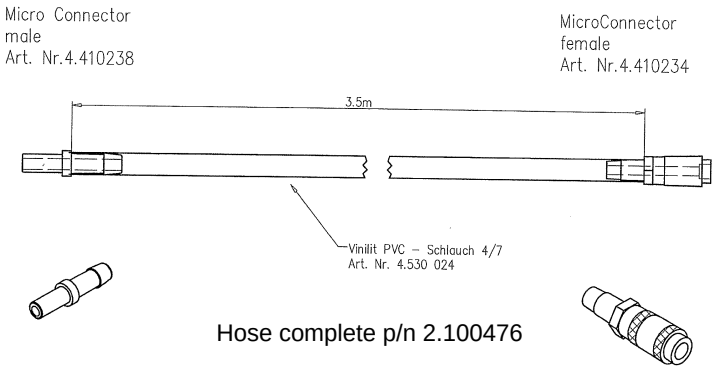


Hose complete p/n 2.100363

Cuff with micro connector

Part No.	Product
2.120021	Cuff Infant, 10.5-18.5cm/4-7.3 inches, latex free
2.120029	Cuff Infant, decorated 10.5-18.5cm/4-7.3 inches, latex free
2.120020	Cuff Child, 18-26cm/7-10.2 inches, latex free
2.120030	Cuff Child, decorated 18-26cm/7-10.2 inches, latex free
2.120018	Cuff Adult, 25-35cm/9.8-13.8 inches, latex free
2.120019	Cuff Large Arm, 33-47cm/13-18.5 inches, latex free
2.120031	Cuff Thigh, 46-66cm/18-26 inches, latex free

s

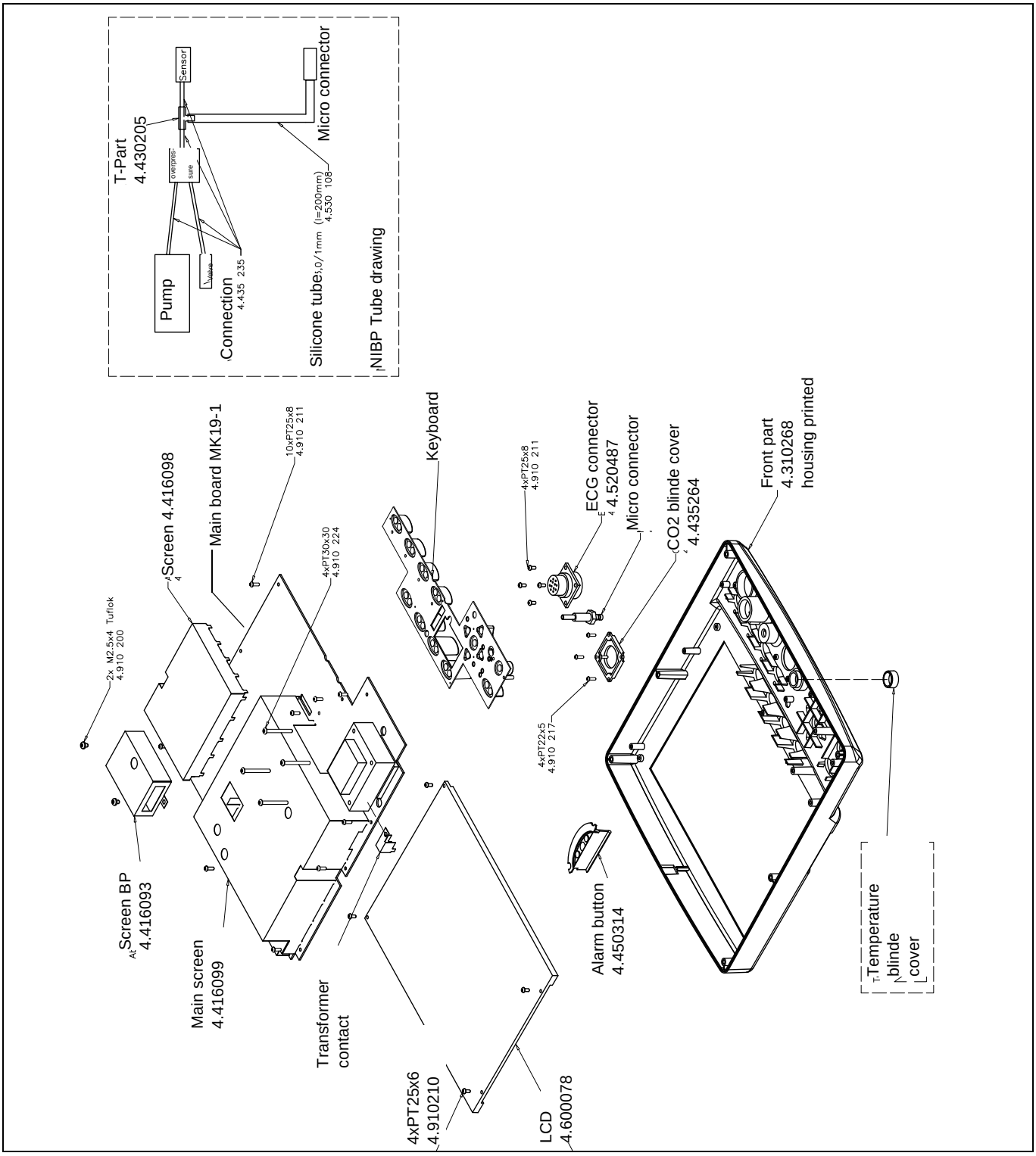


Hose complete p/n 2.100476

SCHILLER
ARGUS LCM/PLUS

10 Drawing and Schematics

10.1 LCM exploded view front



Art. no.: 2.540033 rev.: d

Fig. 10.1 Exploded view F.780041

10.2 LCM exploded view back

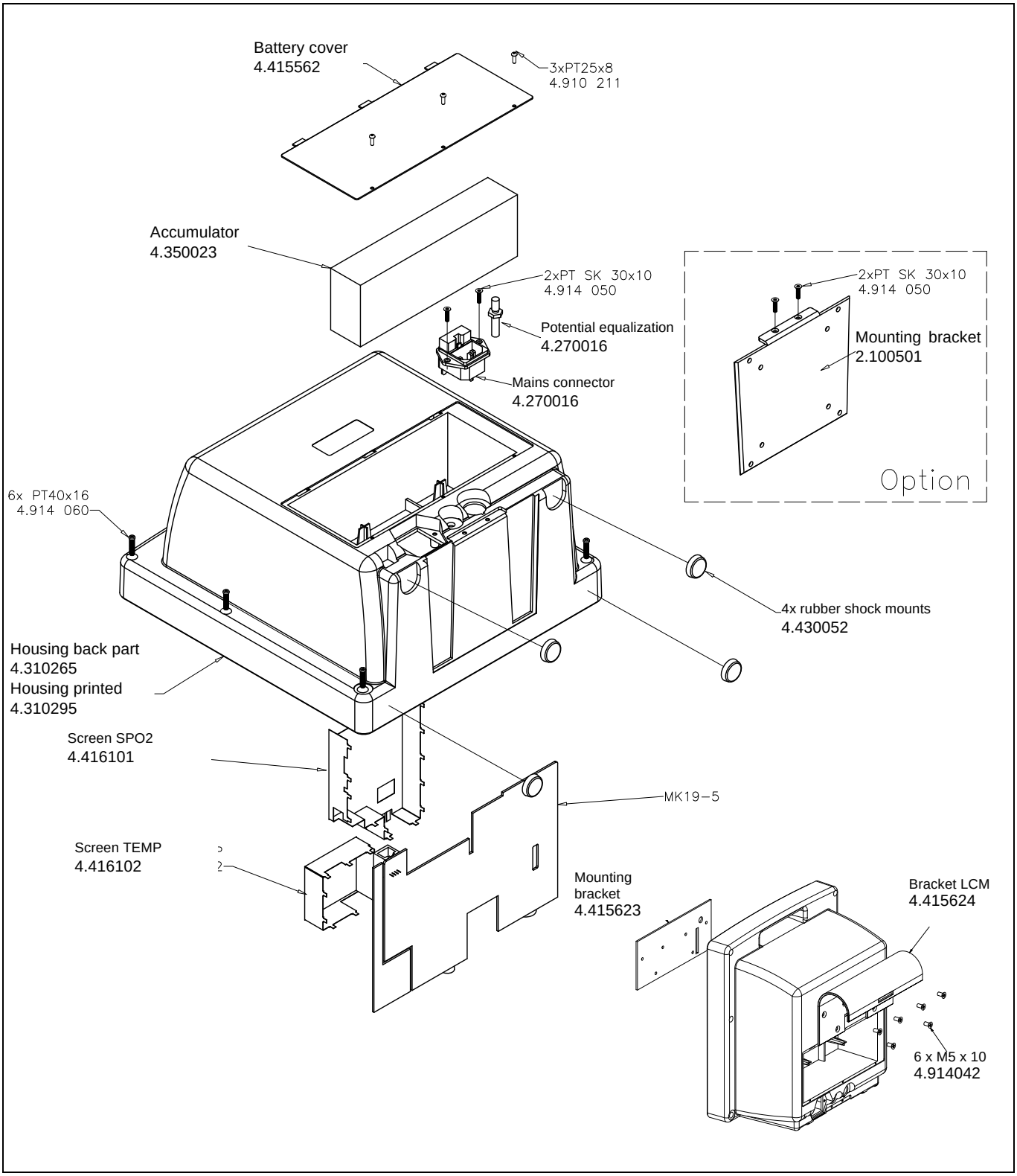


Fig. 10.2 Drawing F.780042 and 780047

Art. no.: 2.540033 rev.: d

10.3 Drawing Temperature, IBP, SPO2 and Nurse call

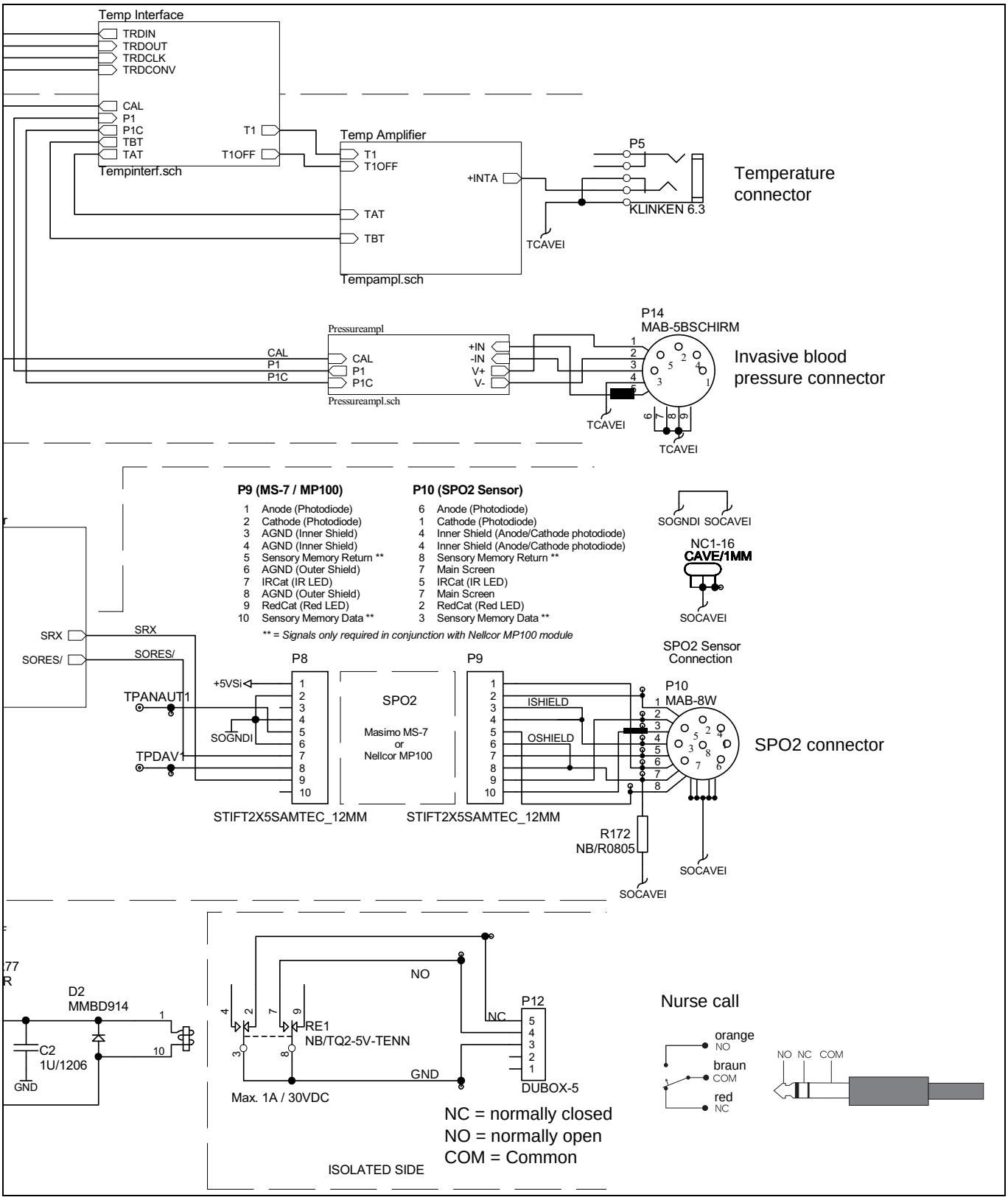


Fig. 10.3 Detail of schematic MK19-53 LCM S.2566

Art. no.: 2.540033 rev.: d

10.4 P1 connector Temperature, IBP, SPO2, Nurse call

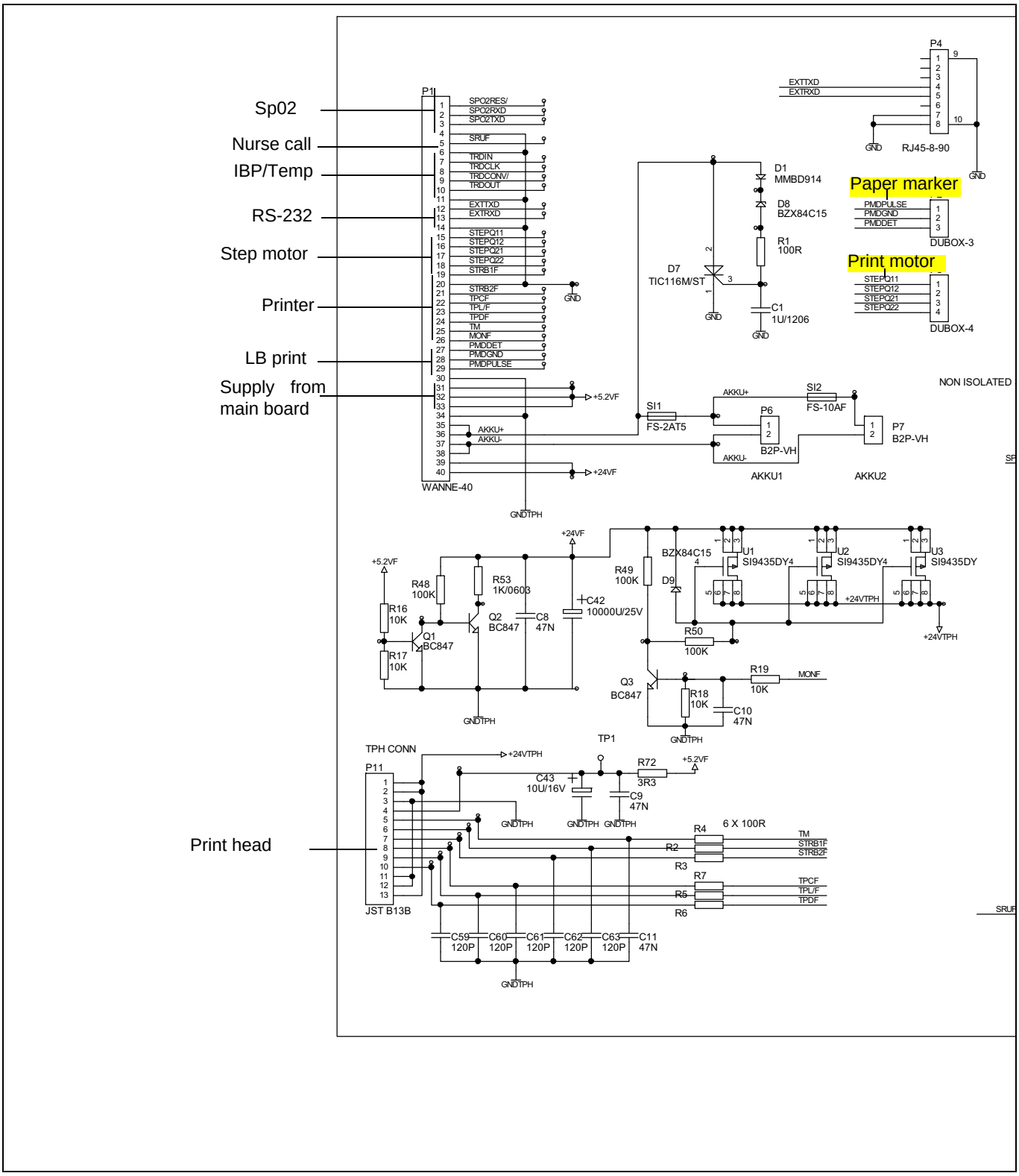
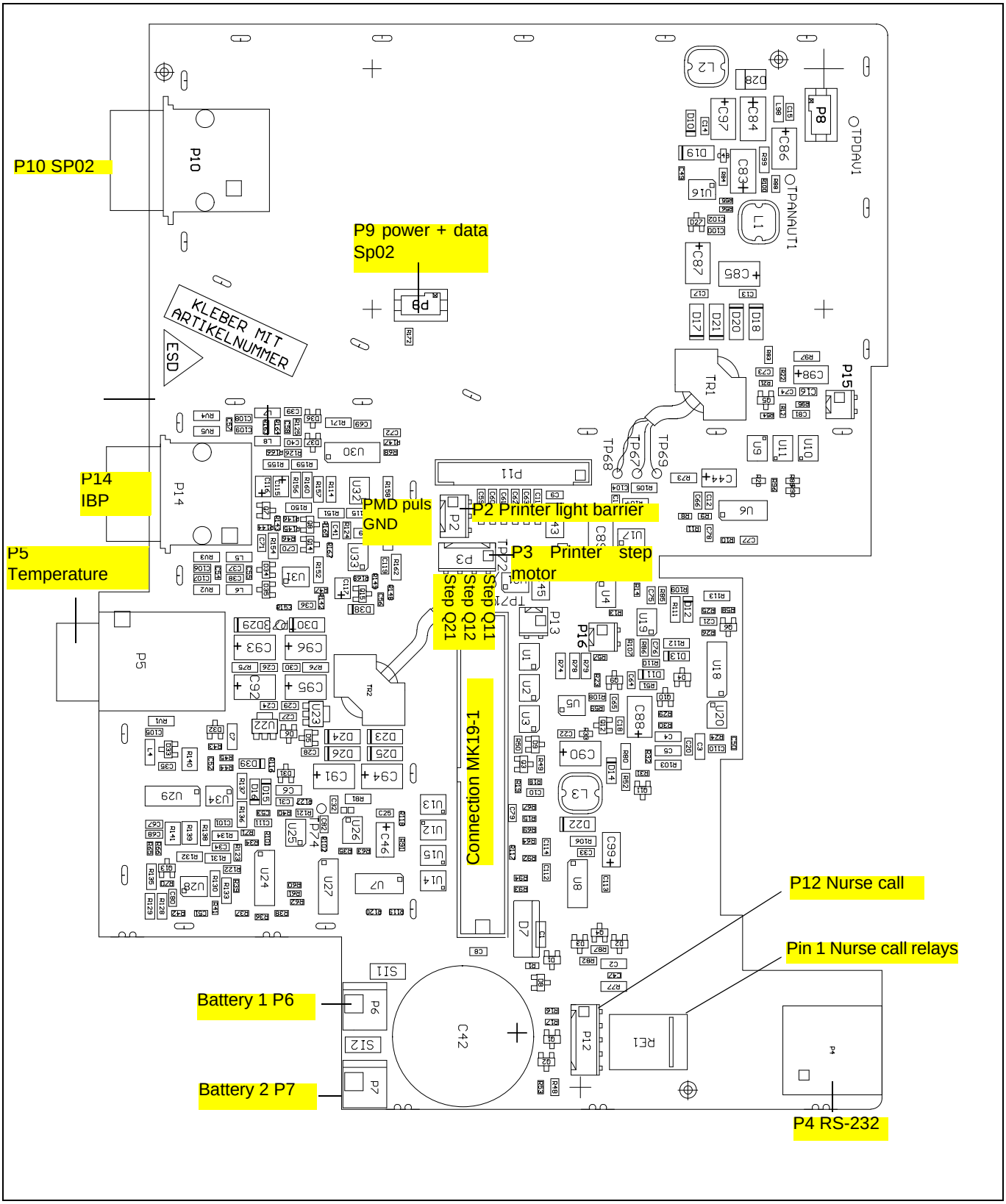


Fig. 10.4 Detail of schematic MK-19 53 LCM S.2566

SCHILLER
ARGUS LCM/PLUS

10.5 MK19-53 print SP02 and Temperature



Art. no.: 2.540033 rev.: d

Fig. 10.5 Drawing MK-19-53 D.2566

10.6 MK19-1 UP board

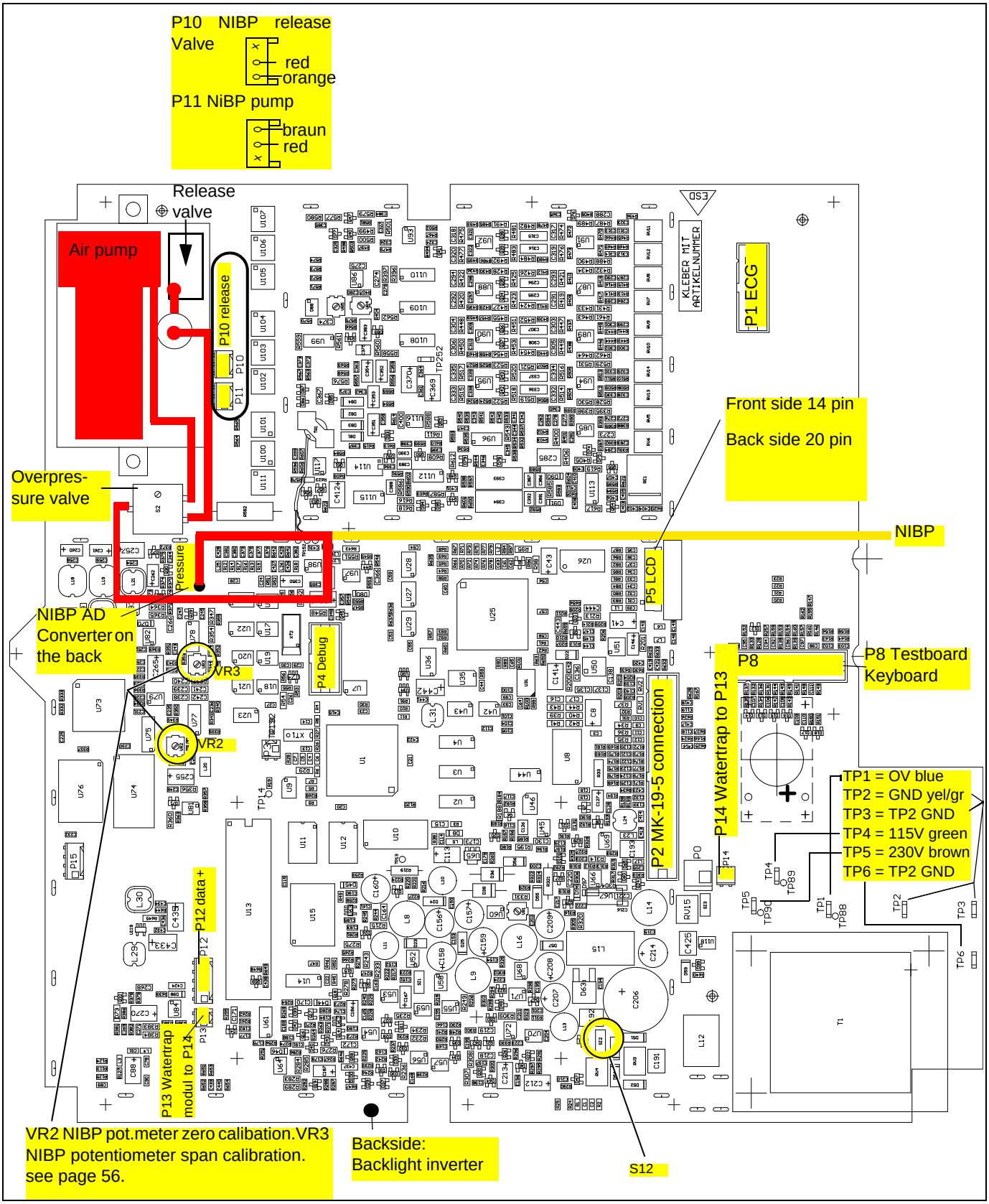


Fig. 10.6 Drawing MK19-1 D2560

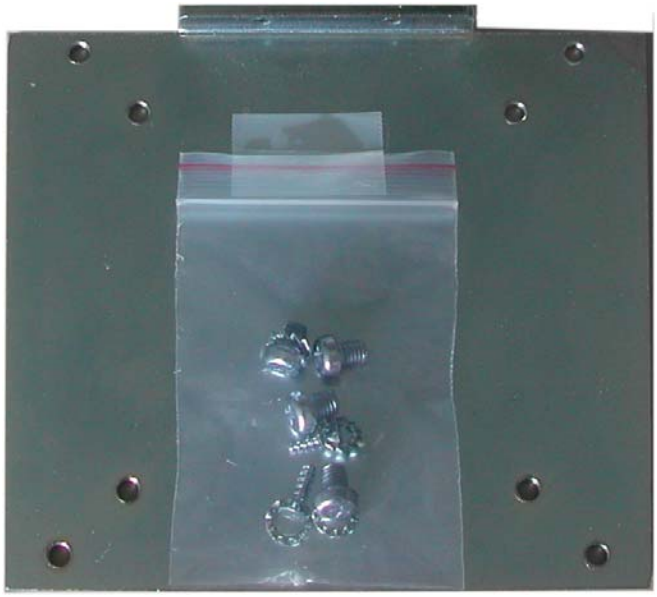
Art. no.: 2.540033 rev.: d

11 Accessories

11.1 Wall mount set p/n 2.100722

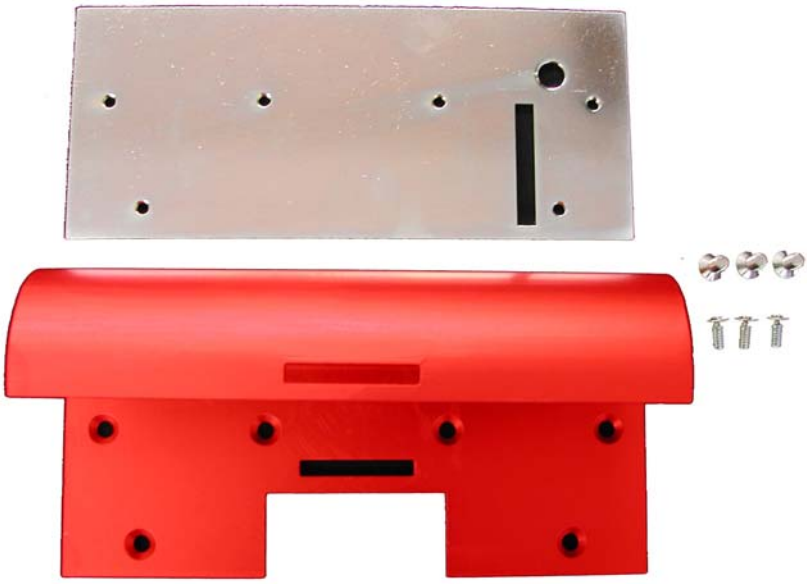
11.2 Roll mount unit light set p/n 2.100499

11.3 Mounting plate p/n 2.100501



Required for wall or roll mount set.

11.4 Bed rail mounting p/n 3.920946



12 Technical Data

12.1 System data

Manufacturer	SCHILLER AG
Device type	ARGUS LCM/PLUS monitoring system
Dimensions	290 x 275 x 180 mm (h x l x w)
Weight	4.6 kg
Protection case	IP20
Power supply	
Voltage	100 - 115 VAC or 220 - 240 VAC 50/60 Hz
Power consumption	28 VA
Battery operation	Up to 1 hour, option with additional battery 2 hours
Fuses	2 x 200 mA (T) at 250 VAC, 2 x 315 mA (T) at 115 VAC
Boardnet supply	11-30 VDC max. 2.5 A The unit is suitable for use in networks according to CISPR 11.
Environmental conditions	
Operating temperature	10 ºC .. 40 Cº relative humidity at 25-95% (non condensing)
Storage temperature	-10 ºC ... 50 Cº relative humidity at 25-95% (non condensing)
Atmospheric pressure	700 ... 1060 hPa
Display	Colour TFT-LCD, backlit
Resolution	SVGA 800 x 600 dots
Dimension diagonal	27 cm, 10.4″
Printer	High resolution thermo-printer
Resolution	8 dots/mm (amplitude-axis), 40 dots/mm (time-axis) at 25 mm/s,
Paper	Thermoreactive, Z-folded, 72 mm width, length approx. 20 m
Print speed	25 mm/s
Printout length	10 second ECG records (equal 4 pages)
Recording tracks	3-channel display, with optimal width of 72 mm, automatic baseline adjustment
Battery	
Battery type	Leakproof, rechargeable lead acid battery
Recharging time	90% full: Approx. 5 hours, 100% full: Approx. 15 hours
Life	Approx. 4 years
Connections	ECG patient cable, SpO_2, NIBP, CO_2, temperature, invasive pressure,
Interfaces	• RS-232 • Nurse call (alarm delay at the signal output component < 0.5 s)

Table 1 of 2

Art. no.: 2.540033 rev.: d

Monitoring functions	
Display	• All vital data numerical and/or graphical
Trend	• All vital data are stored for up to 24 h and can be displayed in tabular or graphical form in intervals of 1, 5, 15, 30, 60, 120 or 240 minutes.
Alarm limits	• The upper and lower limits can be defined freely for all vital data (exception for temperature: only numerical display).
Safety standard	• IEC/EN 60601-1, protection class I, CF classified (with internal power supply) • IEC/EN 60601-2-27
EMC	IEC/EN 60601-1-2 (see details chapter 12.4 Page 131)
Additional requirements	EN 1060-1 and 3 (non-invasive blood pressure recorders part 1)
Conformity	CE according to directive 93/42/EEC class IIb

Art. no.: 2.540033 rev.: d

12.2 Technical data - measured values

12.2.1 ECG

Lead	Simultaneous, synchronous recording of all 9 active electrodes giving 12 leads			
Patient cable	No. of leads	Derivations		
	3	1	N/R/L	RL/RA/LA
	5	7	N/R/L/F7C1	RL/RA/LA/LL/V1
	10	12	N/R/L/F7C1-C6	RL/RA/LA/LL/V1-V6
3p cable	3	6	R/L/F	RA/RLA/LL
Heart rate	20 – 250 beats/min			
Lead display	Selection of 1 or 3 simultaneous leads			
Scale	5/10/20/40 mm/mV programmable			
ECG amplifier				
Sampling frequency	1000 Hz			
Pacemaker detection	≥± 2 mV/≥0.1 ms			
HF calculation	8 beats			
Line frequency filer	Distortion-free suppression of superimposed 50 or 60 Hz sinusoidal interferences by means of adaptive digital filtering			
ECG baseline drift (LCM plus)	<< 0.5 mV			
Pacemaker	Amplitude 1...2 mV, atrial and ventricular			
CMRR	Common mode rejection rate > 100 dB			
ECG Filters				
Diagnostic (Hardware filter)	High/low-pass: hp = 0.05 Hz, lp = 150 Hz for LCMplus and LCMbasic SN < 1000			
Monitoring 1 (Hardware filter)	High/low-pass: hp = 0.5 Hz, lp = 40 Hz for LCMbasic SN > 1000			
Monitoring 2 (Hard & Software)	Hardware see above, SW_{hp} = 0.6 Hz, SW_{lp} = 35 Hz			
Artefact (Hard- and Software)	Hardware see above, SW_{hp} = 2.4 Hz, SW_{lp} = 20 Hz			
Mains filter	50/60 Hz			
Pacemaker detection				
Amplitude	> 2 mV			
Puls width	> 0.1 ms			

12.2.2 Respiration

Measuring method	Impedance method with 3p-, 3-,5-, 10-lead cable
Sampling frequency	250 Hz
Measurement range	Apnea, respiration rate 0-200 inspirations/min
Calculation	8 breaths
Trigger point calculation	32 s
Impedance range	0.1 - 3 Ohm
Accuracy	± 2 %

Art. no.: 2.540033 rev.: d

12.2.3 Temperature

Sensor	YSI 401, rectal, skin or ear
Measurement interval	1x per second
Measurement range	15 °C to 45 °C
Resolution	0.1 °C
Minimum measurement duration	2 min until a measured value is achieved
Accuracy	± 2 °C / 0.36 °F

12.2.4 NIBP - non-invasive blood pressure

Measurement	Automatic or manual
Measuring method	Oscillometric
Measurement range	15 to 300 mmHg
Accuracy	
Max. mean error	± 5 mmHg
Max. standard deviation	± 8 mmHg
Deflation rate	3 to 9 mmHg

12.2.5 IBP - invasive blood pressure

Measurement range	-20 ... 300 mmHg
Sampling rate	500 Hz
Accuracy	• 1 mmHg at 0...100 mmHg or • ±1% at 100...300 mmHg • other sensors may cause lower accuracy
Calibration	Manual
Pulse calculation	8 beats
Sensitivity	5 µV /V/mmHg
Resistance	> 250 ohm

12.2.6 SpO_2 - Saturation periphery O_2 pulsoximetry

Amplifier	Masimo™ MS-3, MS-7, NELL-1
Operation	Normal and sensitive
Sampling rate	62.5 Hz
Accuracy	**SpO_2** • Adults 70 to 100% ± 2 digits • Neonates 70 to 100% ± 3 digits **PP** • 30 ... 199/min ± 4 digits
Calibrated range	70 ... 100% (calibration is fixed, no calibration required)
Measurement range	**SpO_2** 1 ... 100% **PP** 25 ... 240/min
Displayed range	1 ... 100%
PP calculation	8 s

12.2.7 $etCO_2$ - end tidal capnography

Measuring method	Side stream
Displayed range	0 ... 99 mmHg
Suction rate	90/120/200 ml/min
Accuracy	± 3 mmHg at 0 ... 40 mmHg ± 8 mmHg at 41 ... 76 mmHg ± 10 mmHg at 77 ... 99 mmHg
Respiration rate	0 ... 99 inspirations/min
Environmental pressure compensation	Automatic when the unit is switched on and when the watertrap is inserted.

12.3 Options

- Capnography $etCO_2$
- Integrated additional battery
- Integrated thermal printer
- Board net (11 ...30 VDC)
- Nurse call

Art. no.: 2.540033 rev.: d

12.4 EMC information Table

The unit meets the Collateral Standards of Electromagnetic compatibility – Requirements and tests IEC/EN 60601-1-2 the limits and methods of measurement of electromagnetic disturbance characteristics of industrial, scientific and medical radio frequency equipment.

Medical electrical equipment is subject in regard to the electromagnetic compatibility (EMC) and its special precautionary measure.

The unit must in reference to the mentioned EMC-hints in the accompanying documents be installed and operated.

This medical device is intended for use in the electromagnetic environment specified in the following tables 201, 202, 204 and 206. The user of this device should ensure that it is used in such an environment.

12.4.1 Electromagnetic Emissions Table 201

Emission	Test Compliance	Electromagnetic environment guidance
RF emissions CISPR 11	Group 1	This device uses RF energy only for its internal function. Therefore its RF emission are very low and are not likely to cause any interference in nearby electronic equipment.
RF emissions CISPR 11	Class B	The device is suitable for use in all establishments, including 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 6100-3-3	Complies	

12.4.2 Immunity Table 202

Immunity Test	IEC 606101 Test level	Compliance Level	Electromagnetic environment guidance
ESD EN 61000-4-2	±6kV Contact ±8kV Air	±6kV Contact ±8kV Air	Floors should be wood, concrete or ceramic tile. If floors are synthetic, the r/h should be at least 30%.
EFT IEC 61000-4-4	±2kV Power supply lines ±1kV I/O lines	±2kV Power supply lines ±1kV I/O lines	Mains power quality should be that of a typical commercial or hospital environment.
Surge IEC 61000-4-5	±1kV differential mode ±2kV common mode	±1kV differential mode ±2kV common mode	Mains power quality should be that of a typical commercial or hospital environment.
Voltage Dips/Dropout IEC 61000-4-11	< 5 % U_T (> 95 % dip in U_T) for 0,5 cycle 40 % U_T (60 % dip in U_T) for 5 cycles 70 % U_T (30 % dip in U_T) for 25 cycles < 5 % U_T (> 95 % dip in U_T) for 5 s	< 5 % U_T (> 95 % dip in U_T) for 0,5 cycle 40 % U_T (60 % dip in U_T) for 5 cycles 70 % U_T (30 % dip in U_T) for 25 cycles < 5 % U_T (> 95 % dip in U_T) for 5 s	Mains power quality should be that of a typical-commercial or hospital environment. The unit shutoff during the >95% for 5 second disturbance. If theuser of the device requires continued operation during power mains interruptions, it is recommended that the device be powered from an uninterruptible power supply or battery.
Power Frequency 50/60Hz Magnetic Field IEC 61000-4-8	3 A/m	3 A/m	Power frequency magnetic fields should be that of a typical commercial or hospital environment.
NOTE U_T is the AC mains voltage prior to application of the test level.			

Art. no.: 2.540033 rev.: d

12.4.3 Emissions Equipment and Systems that are NOT Life-Supporting Table 204

Immunity Test	IEC 606101 Test Level	Compliance Level	Electromagnetic environment guidance
			Portable and mobile communications equipment should be used no closer to any part of this device, including cable, than the recommended seperation distance (d) calculated from the equation applicable to the frequency of the transmitter **Recommended separation distance:** $d = \frac{3.5}{V_1} \times \sqrt{P}$ for 150 Khz to 80 MHz $d = \frac{3.5}{E_1} \times \sqrt{P}$ for 80 MHz to 800 MHz $d = \frac{7}{E_1} \times \sqrt{P}$ for 800MHz to 2.5 GHz where P is the max power in watts and D is the recommended separation distance in meters. Field strengths from fixed transmitters, as determined by an electromagnetic site[a] survey, should be less than the compliance[b] levels (V_1 and E_1). Interference may occur in the vicinity of equipment marked with following Symbol “non ionizing radiation”
Conducted RF EN 61000-4-6	3 Vrms 150 kHz to 80 MHz	[V_1] = 3 Vrms	
Radiated RF EN 61000-4-3	3 V/m 80 MHz to 2.5 GHz	[E_1] = 3 V/m	

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 radios, amateur radio, AM and FM radio broadcast ant TV broadcast cannot be predicted theoretically with accuracy. To access 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 device is used exceeds the applicable RF compliance level above, the device should be observed to verify normal operation. If abnormal performance is observed, additional measures may be necessary, such as reorienting or relocation the device.

b Over the frequency range 150 kHz to 80 MHz, field strengths should be less than [V_1] V/m.

Art. no.: 2.540033 rev.: d

12.4.4 Recommended Separations distance between portable and mobile RF communications equipment and the device Table 206

The user of the device can help prevent electromagnetic interference by maintaining a minimum distance between portable and mobile RF communications equipment (transmitter) and this device as recommended below, according to the maximum output power of the communication equipment

Max Power Output	Separation distance according frequency of the transmitter [m]		
[Watts]	150 kHz to 80 MHz $d = \frac{3.5}{V_1} \times \sqrt{P}$	80 MHz to 800 MHz $d = \frac{3.5}{E_1} \times \sqrt{P}$	800 MHz to 2.5 GHz $d = \frac{7}{V_1} \times \sqrt{P}$
0.01	0.12	0.12	0.23
0.1	0.37	0.37	0.73
1	1.17	1.17	2.3
10	3.7	3.7	7.3
100	11.7	11.7	23

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 1 To calculate the recommended separation distance of transmitters in the frequency range at 80 MHz to 2,5 GHz an additional factor of 10/3 was used , to limit the possibility for the patient area that unintentional brought in mobile or portable communication equipment cab cause any disturbance.

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

13 Index

Art. no.: 2.540033 rev.: d

Art. no.: 2.540033 rev.: d

Test protocol measurement Check

Tested device

❒ Argus LCM, SN 781._ _ _ _ _, A ❒ B ❒ D ❒ E ❒ SW version: ___. ____, SW version NIBP: ___. ____

❒ Argus LCM plus, SN 780._ _ _ _ _, A ❒ B ❒ D ❒ E ❒ SW version: ___. ____, SW version NIBP: ___. ____

Used tools

Tools	S-Art. no.:	Other Art. no.:	Software no.:/Rev.
Patient simulator with accessories and CO option ARSI-2	2.200218		
Pressure test cylinder 500 ml	3.310993		
Reference recorder ”Delta Cal” for invasive pressure	2.210055		
IBP/Temperature test box LCM	2.320011		
IBP cable for test box	4.520677		
Temperature cable for test box	4.520678		
SpO2 test plug Masimo	2.100433		
Nurse call tester	2.320012		
LCM-PC link cable	2.310208		

Result

Passed ❒ **Failed** ❒

Remarks:

_____

_____

_____

_____

Date: ___ . ___ . ___

Company name: _____

Name of tester: _____ **Signature:** _____

Art. no.: 2.540033 rev.: d

14.1 ECG Test

Measurement/Reference	Current value	Passed ❒ / Failed ❒
5.3.1 Amplitude Check page 51		
Amplitude on the printout and screen is 10 mm ± 0.25 mm		Passed ❒ / Failed ❒
Heartrate is ± 1b/min		Passed ❒ / Failed ❒
5.3.2 Electrode and Patient cable Check page 51		
With patient connected (good connection, low resistance): -100 to +100mV. An offset of up to -300 to +300mV will give an acceptable recording. or With patient simulator connected: -20 mV to +20 This will depend on the patient simulator used and must be taken as a flexible measurement. or • Udiff = 4000 ± 15 mV page 51		Passed ❒ / Failed ❒
Visual patient cable check		
❒ IEC-Type, ❒ AHA-Type, ❒ Radio Translucent, ❒ HF, ❒		
• 3 lead cable		Passed ❒ / Failed ❒
• 3p lead cable (RA/LA/LL)		Passed ❒ / Failed ❒
• 5 lead cable		Passed ❒ / Failed ❒
• 10 lead cable		Passed ❒ / Failed ❒
• Lead Set		Passed ❒ / Failed ❒
• Neonatal		Passed ❒ / Failed ❒
Remarks:		

14.2 SpO_2 Test

Measurement/Reference	Current value	Passed ❒ / Failed ❒
5.4 SpO_2 test, Masimo page 52		
• PP = 60 b/min ±1 with MS-3 board / MS-7 page 52		Passed ❒ / Failed ❒
• Saturation = 85% ±3 page 52		Passed ❒ / Failed ❒
Visual SpO_2 cable check		
• main cable		Passed ❒ / Failed ❒
• sensor		Passed ❒ / Failed ❒
Remarks:		

Art. no.: 2.540033 rev.: d

14.3 NIBP

Measurement/Reference	Reference value	Displayed value	Passed ❒ / Failed ❒
5.5.1 Cuff over pressure test page 54			
• At 330 mmHg the valve has to open and the pressure must decrease to 0 mmHg. page 54	--	--	Passed ❒ / Failed ❒
5.5.2 Leak rate and cuff pressure tolerance test page 54			
• At 330 mmHg the valve has to open and the pressure must decrease to 0 mmHg. page 54. Note leak rate at 50, 120, 200 mmHg.	--	• • •	Passed ❒ / Failed ❒ Passed ❒ / Failed ❒ Passed ❒ / Failed ❒
• Pressure tolerance ± 3 mmHg between the displayed (4) and measured value on the reference pressure device. page 54 Note the values at 50, 120, 200 mmHg	• • •	• • •	Passed ❒ / Failed ❒ Passed ❒ / Failed ❒ Passed ❒ / Failed ❒
5.5.3 Deflation curve test page 55			
• The value dp/dt is max. ± 1 mmHg of the selected value. page 55			Passed ❒ / Failed ❒
• The curve must be linear and not crossing the margin. page 55			Passed ❒ / Failed ❒
Visual check for worn out and porous material			
• Cuff • Cuff • Connector hose (max. length adult 3.5 m, neonatals 1.75)	Size: small Size: medium Size: large		Passed ❒ / Failed ❒ Passed ❒ / Failed ❒ Passed ❒ / Failed ❒
5.5.4 Measurement at a test person page 55			
• Verified by a manual Measurement of NIBP with a stethoscope. Both results has to verified to plausibility. page 55	SYS: DIA: MEAN:	SYS: DIA: MEAN:	Passed ❒ / Failed ❒ Passed ❒ / Failed ❒ Passed ❒ / Failed ❒

Art. no.: 2.540033 rev.: d

14.4 Invasive Blood Pressure

Measurement/Reference	Reference value	Displayed value	Passed ❒ / Failed ❒
5.6.1 IBP test of the LCM page 57			
• max. ±1 mmHg between displayed value and reference pressure. page 57	• 105 mmHg • 180 mmHg	• •	Passed ❒ / Failed ❒ Passed ❒ / Failed ❒
5.6.2 IBP test of the LCM and transducer page 57			
• max. ±1 mmHg (LCM) plus x %-tolerance of the transducer. (see transducer accuracy). page 57 Tolerance System: _____%	• 0 mmHg • 30 mmHg • 50 mmHg • 100 mmHg • 200 mmHg • 300 mmHg	• • • • • •	Passed ❒ / Failed ❒ Passed ❒ / Failed ❒ Passed ❒ / Failed ❒ Passed ❒ / Failed ❒ Passed ❒ / Failed ❒ Passed ❒ / Failed ❒
Visual check o the sensor and cable	--	--	Passed ❒ / Failed ❒

14.5 Temperature

Measurement/Reference	Reference test plug °C	Displayed value [°C]	Passed ❒ / Failed ❒
5.7.1 Temperature test with IBP/temperature test box page 58			
• max . ±0.1°C. If temperature is not in this range replace the module. page 58	• 16.0 °C • 25.3 °C • 34.7 °C • 36.7 °C • 39.3 °C • 44.7 °C	• • • • • •	Passed ❒ / Failed ❒ Passed ❒ / Failed ❒ Passed ❒ / Failed ❒ Passed ❒ / Failed ❒ Passed ❒ / Failed ❒ Passed ❒ / Failed ❒
Visual check o the sensor and cable	--	--	Passed ❒ / Failed ❒
5.7.3 Messung des Isolationswiderstand des Temperaturaufnehmer page 59			
Isolationswiderstand	Ri > 3. MΩ	•	Passed ❒ / Failed ❒

Art. no.: 2.540033 rev.: d

14.6 CO2 test

Measurement/Reference	Current value	Passed ❒ / Failed ❒
5.8.1 Start zero point calibration page 61		
• CO_2 = 0.0 till 0.3% page 61		Passed ❒ / Failed ❒
5.8.2 Start two point calibration page 62		
• CO_2 value = 10% after 1 minute page 62		Passed ❒ / Failed ❒

14.7 Nurse call test

Measurement/Reference	Current value	Passes ❒ / Failed ❒
5.9 Nurse call test page 63		
• Nurse call output activated during alarm		Passed ❒ / Failed ❒

14.8 Safety Tests

Measurement/Reference	Current value	Passed ❒ / Failed ❒
5.10.1 Protective earthing, functional earthing and potential equalization page 65		
• Ground Resistance: ± 0.2 Ω page 34		Passed ❒ / Failed ❒
5.10.2 Continuous leakage and patient auxiliary current page 65		
• add test protocol from safety tester		Passed ❒ / Failed ❒
5.10.3 Dielectric strength page 65		
• Basic insulation test with 1500V (10s) add test protocol from the safety tester		Passed ❒ / Failed ❒

Art. no.: 2.540033 rev.: d