Datex-Ohmeda
Hemodynamic Modules
S/5™ PRESTN Module, M-PRESTN (Rev. 01)
S/5™ RESTN Module, M-RESTN (Rev. 01)
S/5™ PRETN Module, M-PRETN (Rev. 01)

Technical Reference Manual Slot

All specifications are subject to change without notice.

CAUTION: U.S. Federal law restricts this device to sale by or on the order of a licenced practitioner. Outside the USA, check local laws for any restriction that may apply.

Document No. 8005571-1
April 2004

Datex-Ohmeda, Inc.

P.O. Box 7550, Madison
WI 53707-7550, USA
Tel: 1-608-221-1551 Fax: 1-608-222-9147

www.us.datex-ohmeda.com

mailto:product.support.ussub@us.datex-ohmeda.com

Datex-Ohmeda Division, Instrumentarium Corp.
P.O. Box 900, FIN-00031
DATEX-OHMEDA, FINLAND
Tel: +358 10 394 11 Fax: +358 9 146 3310
www.datex-ohmeda.com

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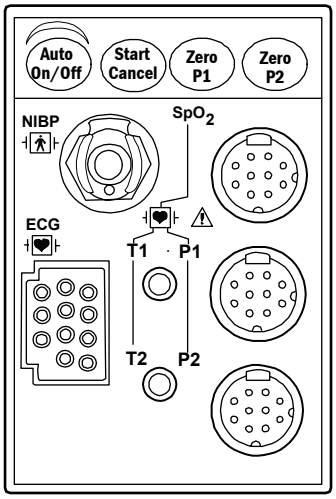
INTRODUCTION

This Technical Reference Manual Slot provides information for the maintenance and service of the hemodynamic modules S/5 M-PRESTN/-RESTN/-PRETN. The modules are double width modules designed for use with S/5 monitors. Later in this manual modules may be referred to w/o the system name S/5 for simplicity.

Please also refer to *Technical Reference Manual* of the S/5 monitor for information regarding system specific information e.g. related documentation, conventions used, symbols on equipment, safety precautions, system description, system installation, interfacing, functional check and planned maintenance.

The M-PRESTN/-RESTN/-PRETN modules provide general hemodynamic parameters.



NOTE: Do not use identical modules in the same monitor simultaneously.
The following modules are considered identical:
M-ESTP/-EST/-ETP,
M-ESTPR/-ESTR/-ETPR,
M-NESTPR/-NESTR/-NETPR,
M-NE12STPR/-NE12STR/-NE12TPR
M-PRESTN/M-RESTN/M-PRETN

Figure 1 S/5 PRESTN Module, M-PRESTN

Table 1 Options of S/5 hemodynamic modules

	Parameter	PRESTN	RESTN	PRETN
P	Two invasive blood pressures	•		•
R	Impedance respiration	•	•	•
E	ECG	•	•	•
S	Pulse oximetry	•	•	
T	Two temperatures	•	•	•
N	NIBP	•	•	•

NOTE: 12-lead ECG measurement requires Display Controller, B-DISP or B-DISPX.

Intended purpose (Indications for use)

The Datex-Ohmeda PRESTN module (model family M-PRESTN) and accessories are indicated for monitoring of hemodynamic parameters of all hospital patients. The hemodynamic parameters of the module comprise ECG including ST-segment and arrhythmia, Impedance respiration, NIBP, Temperature,SpO2 (including monitoring during conditions of clinical patient motion),and invasive blood pressure.

Impedance respiration measurement is indicated for patients aged 3 and up. The NIBP measurement is indicated for patients who weigh 5kg (11 lb.) and up. This device is indicated for use by qualified medical personnel only.

Monitor software compatibility

Datex-Ohmeda PRESTN rev. 01 module is designed for use with Datex-Ohmeda monitors using software as follows:
AM: L-ANE01(A) or later versions;
CCM: S-00C01 rev. 10.5, S-00C02 rev. 10.5 or newer versions;
CAM: S-00A05 rev. 10.9, S-00A06 rev. 10.9, L-00A07 rev. 10.9, L-00A08 rev. 10.9 or newer versions and
CCCM: S-00C03 rev. 10.9, S-00C04 rev. 10.9 or newer versions.

1 SPECIFICATIONS

1.1 General specifications

Module size	75 × 180 × 112 mm
W × D × H	3.0 × 7.1 × 4.4 in
Module weight	0.7 kg / 1.5 lbs
Power consumption	about 6 W
Operation temperature	10 to 40 °C / 50 to 104 °F

1.2 Typical performance

1.2.1 NIBP

NOTE: Non-invasive blood pressure measurement is intended for patients weighing over 5 kg (11 lb.)

Oscillometric measurement principle.

Measurement range	adult	25 to 260 mmHg
	child	25 to 195 mmHg
	infant	15 to 145 mmHg
Pulse rate range accepted	30 to 250 bpm	
Measurement interval	STAT (continuous 5 min), 1, 2.5, 3, 5, 10, 15, 30 and 60 min (1 h), 2 and 4 h	
Typical measuring time	adult	23 s
	infant	20 s
Initial inflation pressure	adult	170 ±10 mmHg
	child	150 ±10 mmHg
	infant	120 ±10 mmHg
Venous stasis	adult	40 ±5 mmHg / 2 min
	child	40 ±5 mmHg / 2 min
	infant	30 ±5 mmHg / 1 min
Cuff widths	please see *User's Guide*	

1.2.2 ECG

Lead selection, 12-lead ECG	I, II, III, aVR, aVL, aVF, V1, V2, V3, V4, V5, V6
Lead selection, other modules	I, II, III, aVR, aVL, aVF, V
Sweep speeds	12.5, 25, 50 mm/sec

DISPLAY FILTER

Diagnostic, 12-lead ECG	0.05 to 150 Hz
Diagnostic, other modules	0.05 to 100 Hz
Monitoring	0.5 to 30 Hz (-3 dB, with 50 Hz reject filter) 0.5 to 40 Hz (-3 dB, with 60 Hz reject filter)

ST filter	0.05 to 30 Hz (-3 dB, with 50 Hz reject filter) 0.05 to 40 Hz (-3 dB, with 60 Hz reject filter)

HEART RATE FROM ECG

Range	30 to 250 bpm
Accuracy	±5 bpm or ±5 %, whichever is greater
Resolution	1 bpm
Update interval	5 s
Averaging time	10 s

ST LEVELS (in main software)

ST level range	-9 to +9 mm (-0.9 to +0.9 mV)
Resolution	0.1 mm (0.01 mV)
Averaging	calculated from 8 QRS

SYNCHRONIZATION

Direct ECG	analog output of ECG, 1 V/1 mV
Pacer	5 V and 0.5 to 2.5 ms pulse, < 30 ms after pacer peak
Defibrillator	5 V and 10 ms pulse, < 35 ms after R-point synchronization

1.2.3 Pulse oximetry

Measurement range	0 to 100 %
Calibration range	70 to 100 %
Accuracy[1]	100 to 70 %, ±2 digits ±3 digits during clinical patient motion 69 to 0 %, unspecified
Display resolution	1 digit = 1 % of SpO_2
Display averaging time	20, 10 sec, beat-to-beat
Pulse beep pitch	varies with SpO_2 level

The monitor is calibrated against functional oxygen saturation SpO_2 func.

PULSE RATE FROM PLETH

Measurement range	30 to 250 bpm
Accuracy	30 to 100, ±5 bpm, 100 to 250, ±5 %
Resolution	1 bpm
Display averaging	10 s

Adjustable pulse beep volume.

PLETH WAVEFORM

Scales	2, 5, 10, 20, 50 mod%, Auto

Start up scale is 20 mod% if AUTO is not selected to be the default setting.

1.2.4 Temperature

Measurement range	10 to 45 °C (50 to 113 °F)
Measurement accuracy	±0.1 °C (25 to 45.0 °C)

1 Accuracy is based on deep hypoxia studies with volunteered subjects during motion and non-motion conditions over a wide range of arterial blood oxygen saturations as compared to arterial blood CO-Oximetry.

	±0.2 °C (10 to 24.9 °C)
Display resolution	0.1 °C (0.1 °F)
Temperature test	automatic (every 10 min)
Probe type	compatible with YSI 400 series
Single use sensors	±0.2 °C (25 to 45.0 °C) ±0.3 °C (10 to 24.9 °C)

1.2.5 Invasive blood pressure

Measurement range	-40 to 320 mmHg
Measurement accuracy	±2 mmHg or ±5 %
Zero adjustment range	±150 mmHg
Calibration range	±20 %
Scales	upper limit is adjustable between 10 and 300 mmHg in steps of 10. Lower limit is 10 % of selected upper limit below zero.
Sweep speed	12.5, 25, 50 mm/s

DIGITAL DISPLAY

Range	-40 to 320 mmHg
Resolution	±1 mmHg

WAVEFORM DISPLAY

Range	-30 to 300 mmHg

PULSE RATE FROM ARTERIAL PRESSURE

Measurement range	30 to 250 bpm
Resolution	1 bpm
Accuracy	±5 bpm or ±5 % whichever is greater

1.2.6 Respiration

NOTE: The respiration measurement is intended for patients over three years old

Measurement range	4 to 120 bpm
Accuracy	±5 bpm or ±5 %
Resolution	1 bpm
Averaging time	30 s
Update interval	10 s

RESPIRATION WAVEFORM

Sweep Speeds	6.25 mm/s and 0.625 mm/s

1.3 Technical specifications

1.3.1 NIBP

Deflation rate, PR dep.	3 to 8 mmHg/s	
Inflation time	20 to 185 mmHg, 1 to 5 s	
Automatic software control, max. inflation pressure		
	adult	280 ±10 mmHg
	child	200 ±10 mmHg
	infant	145 ±5 mmHg
Over pressure limit, stops measurement after 2 seconds		
	adult	320 mmHg
	child	220 mmHg
	infant	160 mmHg

The safety circuit limits the maximum cuff pressure to 320 mmHg in adult/child mode or 160 mmHg in infant mode. Independent timing circuit limits pressurizing (>15 mmHg) time to 3 minutes maximum in adult/child mode, and 90 seconds at (>5mmHg) in infant mode.

Zeroing to ambient pressure is done automatically.

Inflation pressure is adjusted according to the previous systolic pressure, typically 40 mmHg above. If the systolic pressure is not found, inflation pressure is increased typically 50 mmHg.

Max. measurement time	adult	120 s
	child	120 s
	infant	75 s

Pressure transducer accuracy is better than ±3 mmHg or ±2 % whichever is greater.
Max. error ±4 mmHg.

Protection against electrical shock	Type BF defibrillation proof

1.3.2 ECG

Defibrillation protection	5000 V, 360 J
Recovery time	5 s
Input impedance	>2.5 MΩ (10 Hz)
CMRR	≥95 dB (ST)
System noise	<30 μV (p-p, RTI)
Allowable offset	±800 mVDC
Gain range	0.2 to 5.0 cm/mV
Pacemaker pulse detection	2 to 700 mV, 0.5 to 2 ms pulses
Protection against electrical shock	Type CF defibrillator proof

1.3.3 Pulse oximetry

Protection against electrical shock	Type BF defibrillation proof

1.3.4 Temperature

Measurement accuracy	±0.1 °C (25.0 to 45.0 °C) ±0.2 °C (10.0 to 24.9 °C)
Protection against electrical shock	Type CF defibrillation proof

NOTE: The accuracy of the measurement may be different from the specified, depending on transducer/probe used. Please refer to the transducer/probe specification.

1.3.5 Invasive blood pressure

DIGITAL DISPLAY AVERAGING
Digital displays Art and P1 are averaged over 5 seconds and updated at 5 seconds intervals. All other pressures have respiration artifact rejection.

Accuracy	±5 % or ±2 mmHg, whichever is greater
Transducer and input sensitivity	5 μV/V/mmHg, 5 VDC, 20 mA max current
Filter	0 to 4 - 22 Hz adjustable
Zero set accuracy	±1 mmHg
Calibration resolution	±1 mmHg
Zero time	less than 15 s
Protection against electrical shock	Type CF defibrillation proof

NOTE: The accuracy of the measurement may be different from the specified, depending on transducer/probe used. Please refer to the transducer/probe specification.

1.3.6 Respiration

Excitation frequency, 12-lead ECG	31.25 kHz
Breath detection	automatic, range 0.3 to 6 Ω manually adjustable minimum detection: 0.2, 0.4, 0.6, 0.8, 1.0
Input dynamic range	0.2 to 32 Ω
Input impedance range	100 to 5000 Ω
Respiration Rate	min. 4 bpm max. 120 bpm
Lead off detection	>3 MΩ

2 FUNCTIONAL DESCRIPTION

2.1 Measurement principle

2.1.1 NIBP

NIBP (Non-Invasive Blood Pressure) is an indirect method for measuring blood pressure.

The NIBP measurement is performed according to the oscillometric measuring principle. The cuff is inflated with a pressure slightly higher than the presumed systolic pressure, and deflated at a speed based on the patient's pulse, collecting data from the oscillations caused by the pulsating artery. Based on these oscillations, values for systolic, mean, and diastolic pressures are calculated.

The following parts are necessary for the NIBP measurement:

- M-PRESTN/-RESTN/-PRETN module
- twin hose (adult or infant model)
- blood pressure cuffs (various sizes)

2.1.2 ECG

Electrocardiography analyzes the electrical activity of the heart by measuring the electrical potential produced with electrodes placed on the surface of the body.

ECG reflects:

- electrical activity of the heart
- normal/abnormal function of the heart
- effects of anesthesia on heart function
- effects of surgery on heart function

See the *User's Guide* or the *User's Reference Manual* for electrodes positions and other information.

2.1.3 Pulse oximetry

A pulse oximeter measures the light absorption of blood at two wavelengths, one in the near infrared (about 900 nm) and the other in the red region (about 660 nm) of the light spectrum. These wavelengths are emitted by LEDs in the SpO_2 probe, the light is transmitted through peripheral tissue and is finally detected by a PIN-diode opposite the LEDs in the probe. The pulse oximeter derives the oxygen saturation ($SpO_{2)}$ using an empirically determined relationship between the relative absorption at the two wavelengths and the arterial oxygen saturation SaO_2.

In order to measure the arterial saturation accurately, pulse oximeters use the component of light absorption giving variations synchronous with heart beat as primary information on the arterial saturation.

A general limitation of pulse oximetry is that due to the use of only two wavelengths only two hemoglobin species can be discriminated by the measurement.

The modern pulse oximeters are empirically calibrated either against fractional saturation SaO_2frac;

$$SaO_2frac = \frac{HbO_2}{HbO_2 + Hb + Dyshemoglobin}$$ Formula 1

or against functional saturation SaO_2func;

$$SaO_2func = \frac{HbO_2}{HbO_2 + Hb}$$ Formula 2

Functional saturation is more insensitive to changes of carboxyhemoglobin and methemoglobin concentrations in blood.

The oxygen saturation percentage SpO_2 measured by the Datex-Ohmeda module is calibrated against functional saturation SaO_2func. The advantage of this method is that the accuracy of SpO_2 measurement relative to SaO_2func can be maintained even at rather high concentrations of carboxyhemoglobin in blood. Independent of the calibration method, pulse oximeters are not able to correctly measure oxygen content of the arterial blood at elevated carboxyhemoglobin or methemoglobin levels.

Plethysmographic pulse wave

The plethysmographic waveform is derived from the IR signal and reflects the blood pulsation at the measuring site. Thus the amplitude of the waveform represents the perfusion.

Pulse rate

The pulse rate calculation is done by peak detection of the plethysmographic pulse wave. The signals are filtered to reduce noise and checked to separate artifacts.

Probe

The standard probe is a finger clamp probe which contains the light source LEDs in one half and the photodiode detector in the other half. Different kinds of probes are available from Datex-Ohmeda.

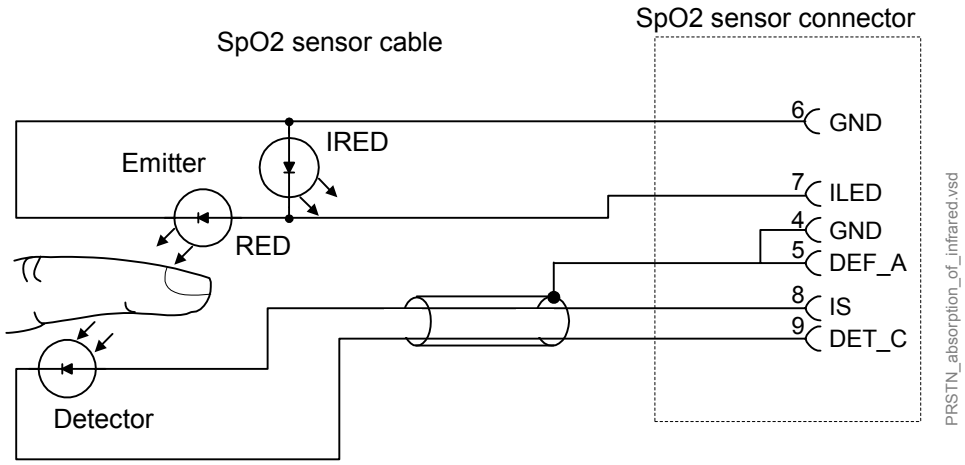


Figure 2 Absorption of infrared light in the finger probe, parts layout and schematic diagram

2.1.4 Temperature

The temperature is measured by a probe whose resistance varies when the temperature changes, called NTC (Negative Temperature Coefficient) resistor.

The resistance can be measured by two complementary methods:

- Applying a constant voltage across the resistor and measuring the current that flows through it
- Applying a constant current through the resistor and measuring the voltage that is generated across it.

In Datex-Ohmeda modules the two methods are combined in the form of a voltage divider. The NTC-resistor is connected in series with a normal resistor and a constant voltage is applied across them. The temperature dependent voltage can be detected at the junction of the resistors, thus producing the temperature signal from the patient. The signal is amplified by analog amplifiers and further processed by digital electronics.

2.1.5 Invasive blood pressure

To measure invasive blood pressure, a catheter is inserted into an artery or vein. The invasive pressure setup, consisting of connecting tubing, pressure transducer, an intravenous bag of normal saline all connected together by stopcocks, is attached to the catheter. The transducer is placed at the same level with the heart, and is electrically zeroed.

The transducer is a piezo-resistive device that converts the pressure signal to a voltage. The monitor interprets the voltage signal so that pressure data and pressure waveforms can be displayed.

2.1.6 Respiration

Impedance respiration is measured across the thorax between ECG electrodes. The respiration signal is made by supplying current between the electrodes and by measuring the differential current from the electrodes. The signal measured is the impedance change caused by breathing. From these impedance changes, respiration rate is calculated, and the respiration waveform is displayed on the screen.

2.2 Main components

2.2.1 M-PRESTN/-RESTN/-PRETN modules

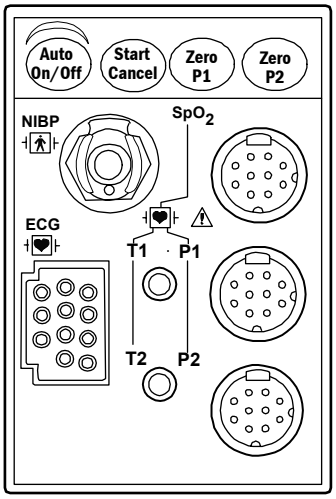


Figure 3 Front panel of M-PRESTN

The **M-PRESTN, M-RESTN, and M-PRETN modules** contain three main PC boards, the STP board, the ECG board, and the NIBP board. They work independently. Each of these has their own processor and software in the processor flash memory.

There are two small boards, the SP input and the ECG input board attached to the front panel of the module. The front panel has seven connectors and four keys. The connectors are two for temperature measurement, two for invasive blood pressure measurement, one for ECG, one for NIBP, and one for SpO_2 measurement. The keys are for NIBP Auto On/Off, NIBP Start/Cancel, P1 zero, and P2 zero.

2.2.2 NIBP board

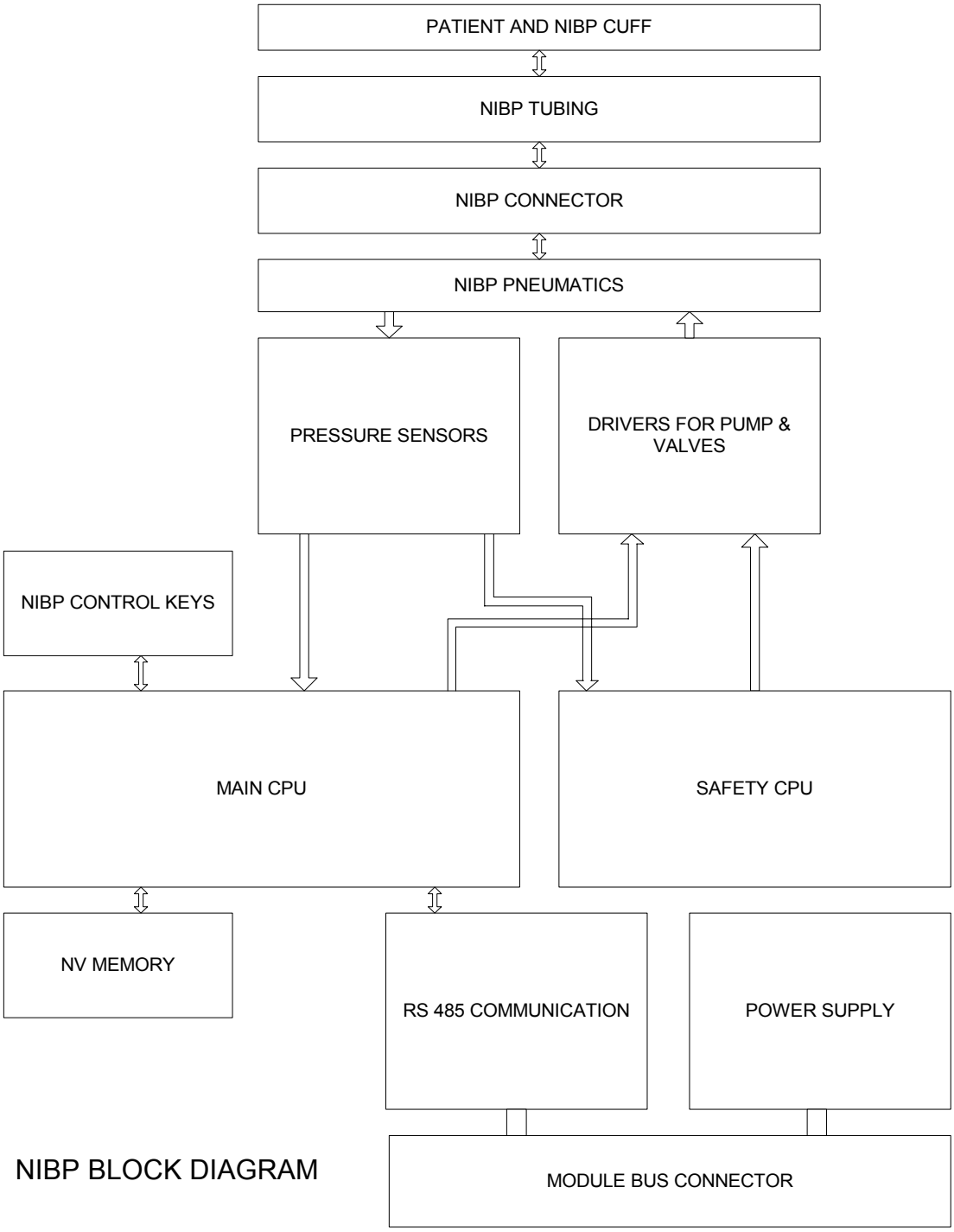


Figure 4 NIBP board functional block diagram

Signal processing

Two signals from the pressure transducers are amplified and sent to the A/D converter. After the converter, digitized signals are sent to the microprocessor for data processing.

The NIBP board is controlled with a H8/3052 microprocessor at 16 MHz oscillator frequency.

Memory

NIBP program memory (processor flash memory) size is 512k × 8. The processor has 4 kBytes RAM and there is also an external RAM memory the size of which is 128k x 8. Variable values of the NIBP measurement are stored into the external RAM. The EEPROM size is 512 x 8 and it is used to store the calibration values for the pressure transducers, the pulse valve constants gained during measurements, the PC board identification, and module serial number.

Software control

Software controls valves and pump. In addition to the individual on/off signals for each component there is a common power switch for the valves and the pump that can be used at pump/valve failures.

In addition to external RS485 reset line the microprocessor system is equipped with its own power-up reset. See the section in the ECG board's description: *"RS485 communication"*

Safety circuit

The NIBP board is equipped with an independent safety circuit to disconnect supply voltages from the pump and the valves if the cuff has been pressurized longer than the preset maximum measurement time, or if the pressure of the cuff is inflated over the specified pressure limit. The maximum measurement time values and pressure limits for different measurement modes have been specified in the technical specification section of this manual.

Pneumatics

Pneumatics of PRESTN module has the following parts:

- **Intake air filter**; for preventing dust and other parts to enter the air pump and the valves.
- **Air pump**: for pumping the measuring pressure of the cuff.
- (**Pulse) Valve**; for producing a linear pressure fall (bleeding) in order to measure the blood pressure of the patient.
  Note that there has been used also two other names **Valve** and **Set valve** to designate pulse valve in service menu.
- **Safety valve**; The safety valve has been intended to be used for deflating the cuff in single fault case, i.e. to prevent too long measurement time or too high inflation pressure of the cuff.
  Note that there has been used also **Exh2 valve** to designate the **Safety valve** in service menu.
- **Main pressure sensor**; for measuring the pressure of the blood pressure cuff and the pressure fluctuations caused by arterial wall movement.
- **Safety pressure sensor** for detection of cuff hose type, cuff loose, cuff occlusion situations etc.and recognising the pressure sensor fault.
- **Cuff connector**; for connecting the cuff.

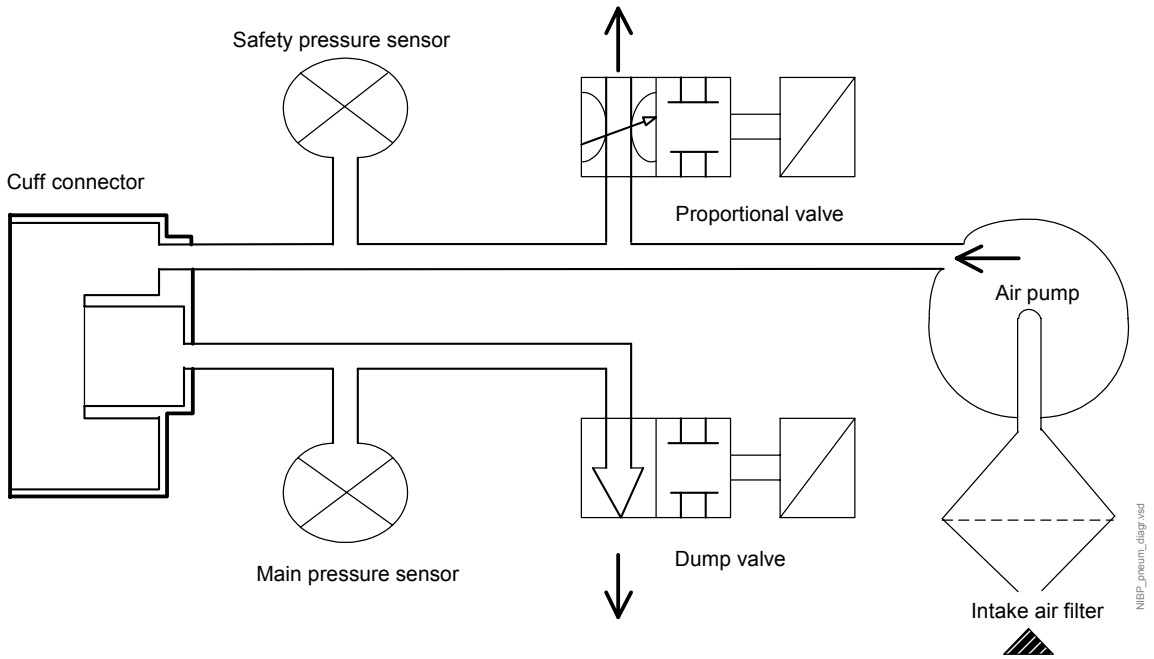


Figure 5 NIBP pneumatics diagram

Power supply section of the NIBP board

All connections are established via 25-pin connector (D-type, female). The module needs +15 V (dirty) power supply to operate. The supply voltage (+15V) is generated in the power supply section of the S/5 monitor. The other voltages needed for the operation of the NIBP measurement are made on the NIBP board.

2.2.3 ECG board in 12-lead measurement

The 12-lead ECG measurement consists of the elements shown in Figure 6. All functions are located in the ECG board except the ECG input unit .

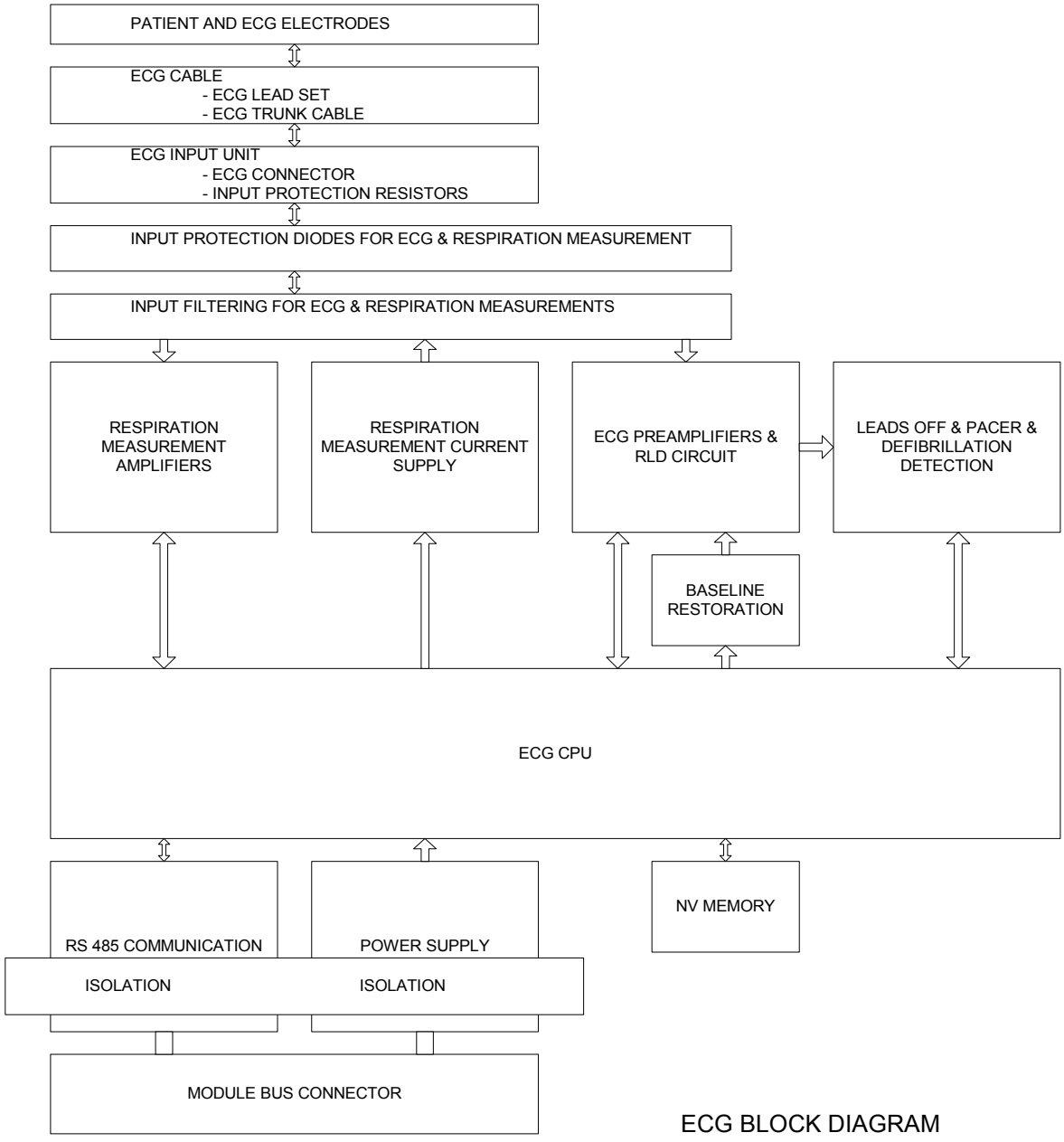


Figure 6 12-lead ECG measurement block diagram

ECG input unit

The ECG input unit consists of the front panel connector and the ECG input connector board with the high voltage protection resistors. The connector for the 12-lead ECG cable is a green 11-pin rectangle shaped connector.

Input protection and filtering

The input protection is implemented with high voltage protection resistors in the ECG input unit and with protection diodes in the ECG board. The input filtering for ECG measurement is done with passive RC filtering.

ECG preamplifiers

The buffer amplifiers are used for each lead. The “Leads off” detection is implemented by measuring the output level of the input buffer amplifiers with A/D converter of CPU. The ECG signals are measured using differential amplifiers.

ECG amplifiers and baseline restoration

The function of the ECG amplifiers and baseline restoration is to amplify the signal and to restore the baseline of the signal in the middle of the display after the change of the signal level e.g. after the change of the DC offset voltage.

Pacer detection

Pacer detection has been made by using three slew rate detector circuits. The pacer detection amplifiers have been realized at the front of the slew rate detectors independently from the ECG measuring channels.

Respiration impedance supply

The 31.25 kHz sine wave generator is used as the respiration measurement signal supply. Analog switches are used for connecting the sine wave to the ECG leads to be measured.

Respiration impedance amplifiers

Buffer amplifiers are used in respiration measurement. Analog switches are used for selecting the measurement leads. There are also additional amplifiers for increasing the respiration signal gain. When ECG measurement is 5/12-lead, the respiration measurement is always done between R and F, independently on the ECG lead selection. When ECG measurement is 3-lead, then the respiration measurement is done at the same lead as the ECG measurement (I, II or III).

ECG CPU

The CPU is a 16 bit H8/3052 single-chip microcomputer. It contains 128 kbytes of flash memory and 4 kbytes of RAM. The clock frequency is 16 MHz.

RS485 communication

The communication to the CPU board of the monitor uses RS485 protocol. The RS485 driver circuits are optically isolated from the processor of the module. PWM signal is used for direct ECG signal. Direct ECG signal is available from the X2 connector of the UPI board or from the PT module.

Power supply

The ECG board has a driver controlled half bridge switching power supply with 5 kV isolation. The supply voltages have been regulated with linear regulators.

2.2.4 ECG filtering

The S/5 monitors have three ECG filtering modes:

MONITORING	0.5 to 30 Hz (with 50 Hz reject filter) 0.5 to 40 Hz (with 60 Hz reject filter)
DIAGNOSTIC 12-lead ECG	0.05 to 150 Hz
ST FILTER	0.05 to 30 Hz (with 50 Hz reject filter) 0.05 to 40 Hz (with 60 Hz reject filter)

The purpose of filtering is to reduce high frequency noise and low frequency (e.g. respiratory) movement artifacts.

Monitor filter is used in normal monitoring. Diagnostic filter is used if more accurate diagnostic information is needed. ST filter gives more accurate information of ST segment, but reduces high frequency noise.

The high-pass filters 0.5 Hz and 0.05 Hz are done with software. The monitor sends a command to the hemodynamic module determining which of the corner frequencies 0.5 Hz or 0.05 Hz is to be used.

The 50 Hz and 60 Hz reject filters are both low-pass filters with zero at 50 Hz or 60 Hz correspondingly. They are software based filters used for the mains supply filtering. With these filters the 3 dB value for low-pass filter is 30 Hz or 40 Hz.

In diagnostic mode the upper frequency is 150 Hz and it is limited by software.

2.2.5 STP board

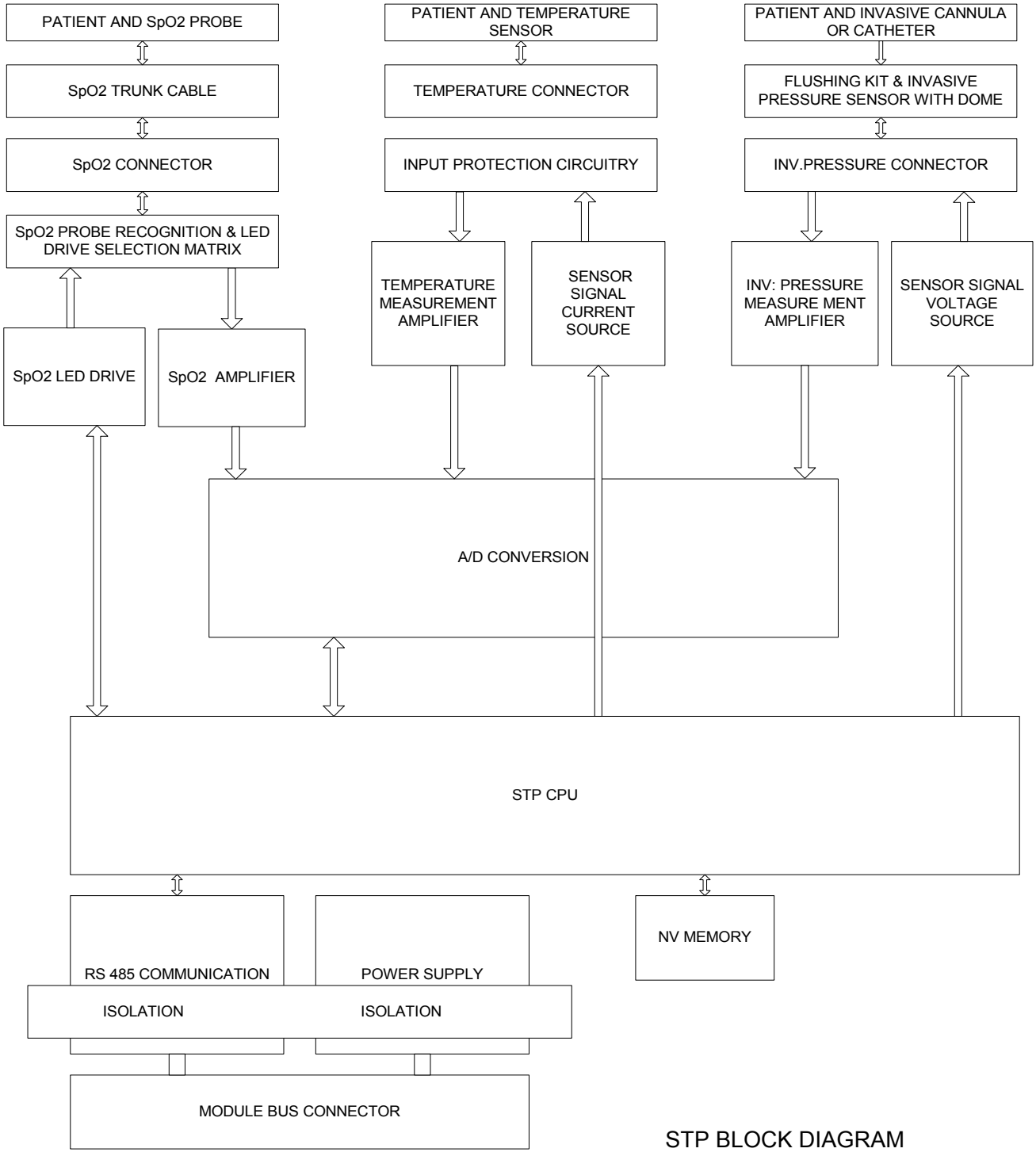


Figure 7 STP board block diagram

Microprocessor unit

The CPU is a 16 bit H8/3052 single-chip microcomputer. It contains 128 kbytes of flash memory and 4 kbytes of RAM. The clock frequency is 16 MHz.

High speed I/O is used to obtain pulse control sequence necessary for pulse oximetry measurement. Timing for the clock is from the oscillator.

Temperature measurement unit

The NTC-resistor value in the probe depends on the patient's temperature. It is measured with the following principle described below.

The constant current source is supplied about 7μA current through the temperature sensor (YSI 400-series NTC resistor). The constant current is caused a voltage over the temperature sensor (NTC resistor). The voltage over the temperature sensor is amplified in a differential amplifier stage. The amplified voltage is transferred to a controller of the STP board through an A/D converter.

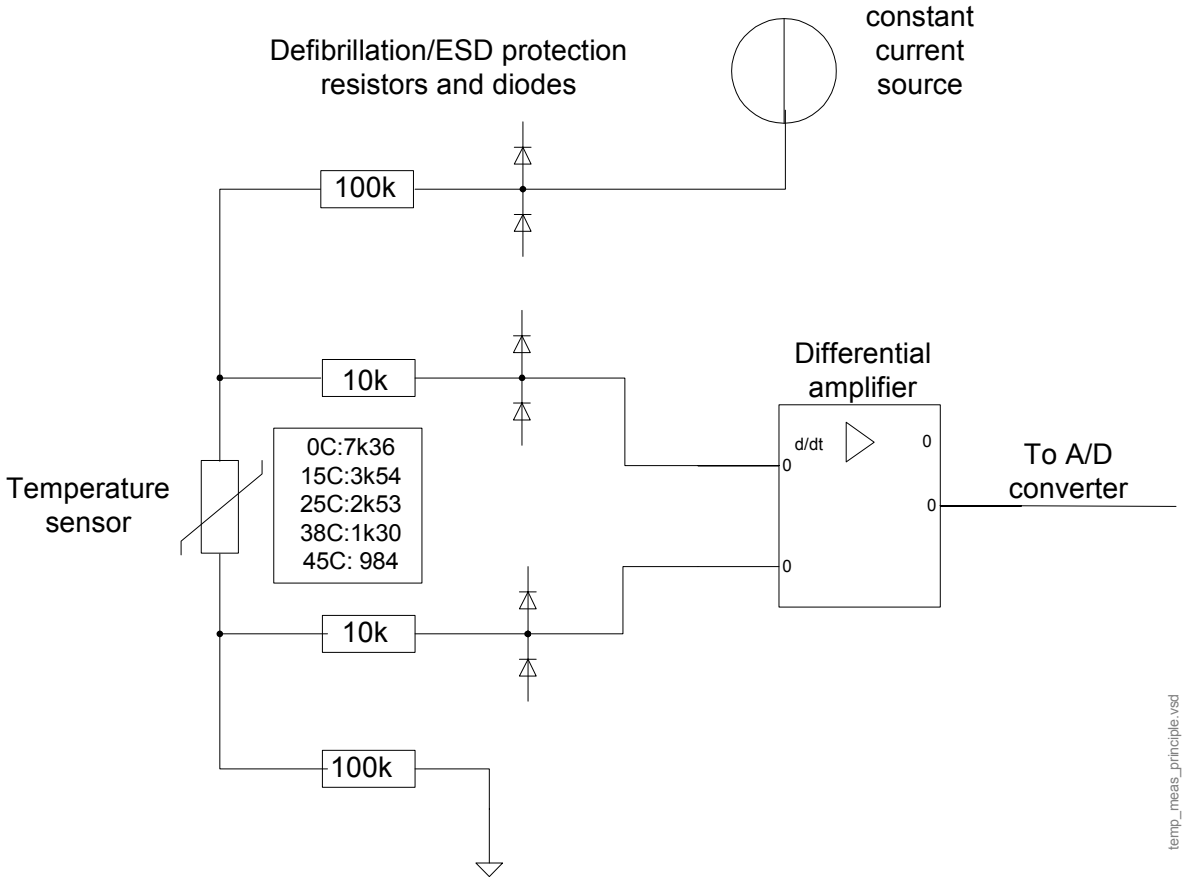


Figure 8 Temperature measurement principle

Invasive blood pressure measurement unit

An isolated +5 V voltage is supplied to the pressure transducer. The differential voltage, which depends on the pressure and the supplied voltage, is calculated from the bridge connection (see the formula below).

$U_{out} = U_{in} \times$ pressure $\times$ 5 V, where U_{in} is 5 V

$\Rightarrow U_{out} = 25\ V \times$ pressure [mmHg]

Pressure amplification is realized in the instrumentation amplifier. The gain of the amplifier is set to keep the level of the signal transferred to A/D converter within the measurement range even when there are circumstantial offsets or offsets caused by the transducer. There is a filter before the amplifier to attenuate high frequency disturbances.

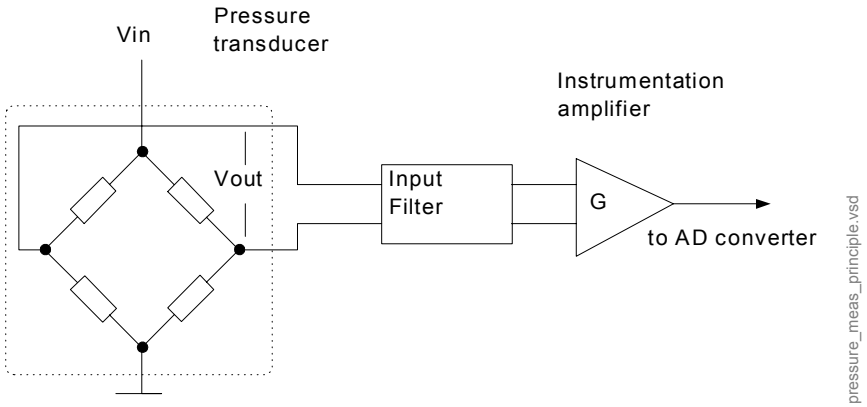


Figure 9 Pressure measurement principle

Pulse oximetry measurement section

LED control signals

The D/A converters of the microcontroller on STP board set the LED intensity adjustment values for the infrared- and red LEDs of SpO2 probe. The microcontroller on the STP board switches ON (to the adjusted intensity) and OFF the SpO2 probe LEDs according to the predetermined sequence.

LED driving circuit

Differential amplifiers measure the LED currents (LED current indication) of SpO2 probe over the shunt resistors placed in the LED current paths. The LED driving voltages (LED voltage indication) are measured from the driver circuitry. The LED driving circuits also have MOSFET transistor matrix to enable the use of different probe configurations.

Measured signal preamplification

The preamplifier is bipolar/single-ended current-to-voltage converter with adjustable gain. A higher gain is used for measuring thin tissue. The preamplification stage has also ambient light reduction and second amplifier stage.

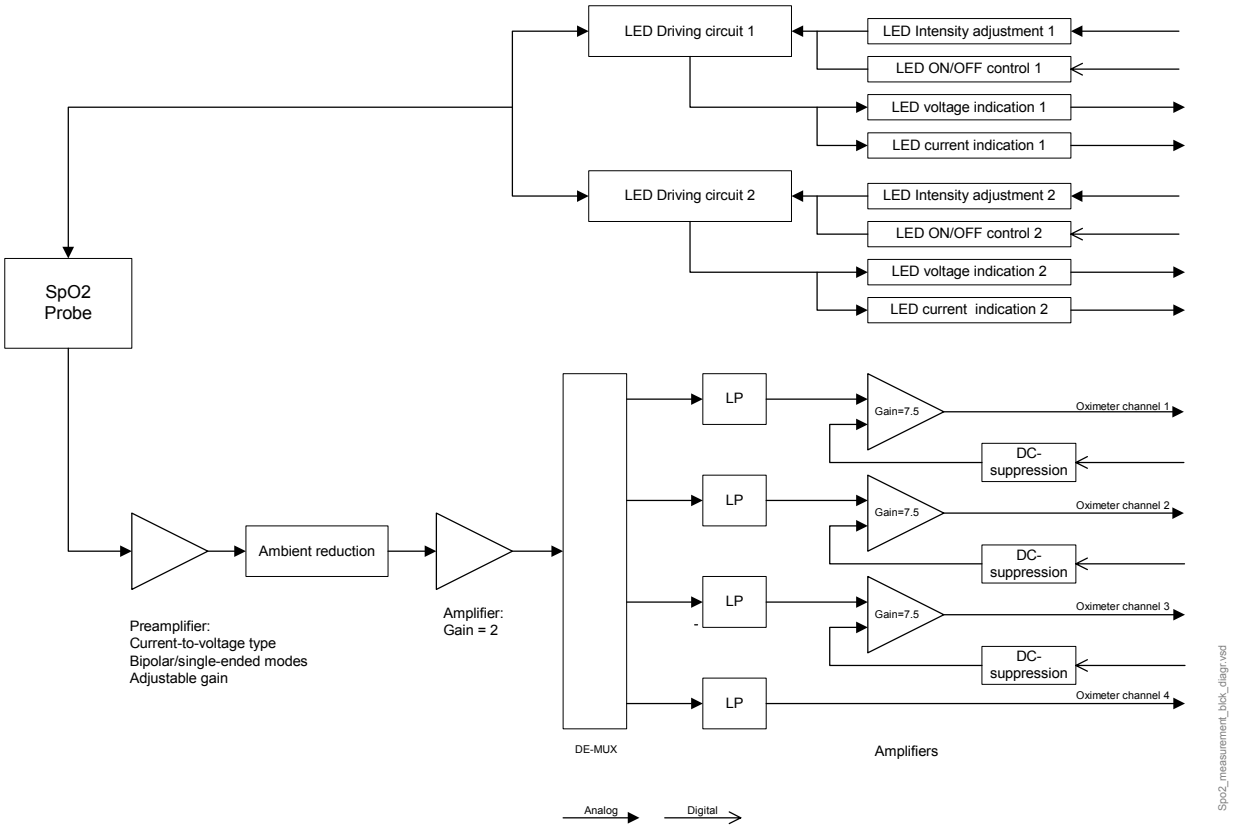


Figure 10 Pulse oximetry measurement block diagram

Red and infrared channel separation

The detector signal is possible to multiplex to four different channels depending on the content of the signal. The detector signal must at least multiplex into infrared- and Red signals. Other channels are for e.g. diagnostic purposes.

Serial communication

An RS485 type bus driver makes the serial communication between the module and the frame. Data transmission rate is 500kbps.

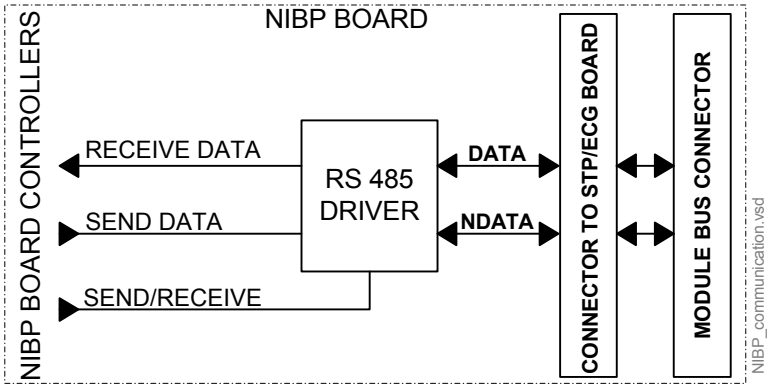


Figure 11 Serial communication of NIBP board

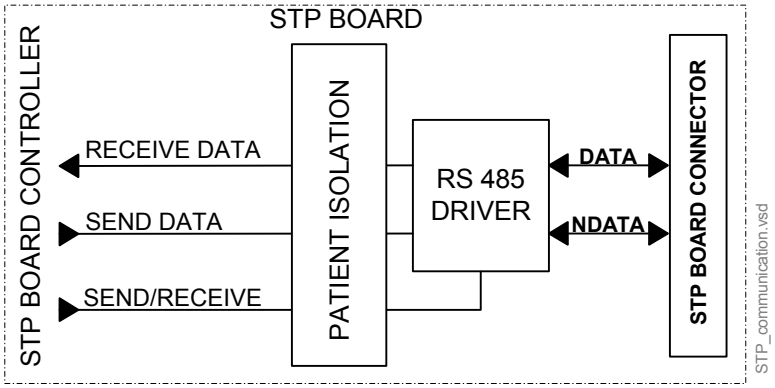


Figure 12 Serial Communication and Isolation of STP board

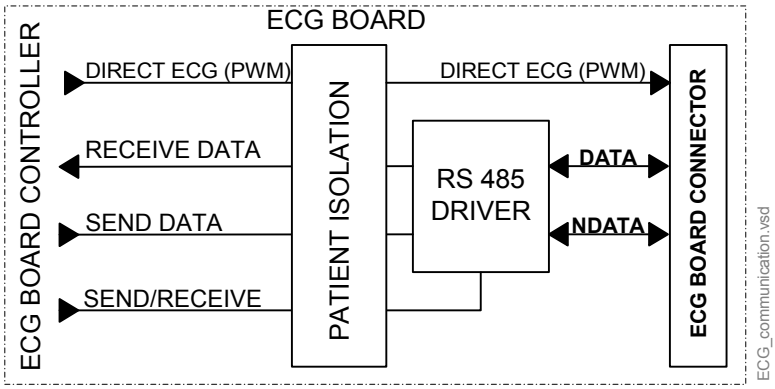


Figure 13 Serial Communication and Isolation of ECG board

Signals and isolation barrier

The communication signals transfer over the isolation barrier by using high isolation voltage (6kV) opto isolators.

Power supply section

The power for the electronics on the floating part of the STP and the ECG boards is made on each board with the switching power supplies connected to a high voltage isolated transformer. The switching power supplies on the STP and ECG boards are synchronized to the frequency, about 340kHz of the switching power supply on the NIBP board. The PRESTN module uses only +15VD voltage of the frame. The other voltages of the measuring boards are made by the switching power supplies and regulators or the linear regulators. Each measuring board is protected against overloading with PTC type automatic fuses.

2.3 Connectors and signals

2.3.1 Module bus connector (on the NIBP board)

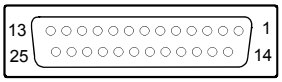


Figure 14 Module bus connector (X1) pin layout

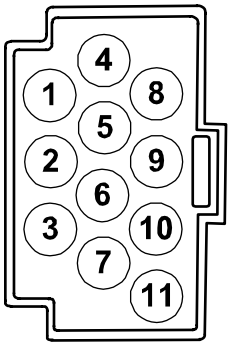
Table 2 Module bus connector description

Only the shaded signals of the table below are valid for the PRESTN module

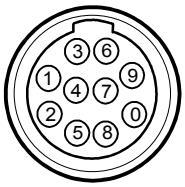
Pin No	I/O	Signal	Note
1	I	RESET_RS485	
2	I	-15 VDC	
3	I	+15 VDIRTY	
4	I	+15 VDC	
5	I/O	NDATA_RS485	
6	I/O	DATA_RS485	
7		Ground & Shield	
8	I	-RESET_RS485	
9	I	CTSB	
10	O	RTSB	
11	I	RXDB	
12	O	TXDB	
13		Ground & Shield	
14	I	+32 VDIRTY	
15	I	GroundDIRTY	
16	I	CTSC	
17	O	RTSC	
18	I	RXDC	
19	O	TXDC	
20		ON/STANDBY	
21	O	PWM_ECG	
22		RXDD_RS232	
23		TXDD_RS232	
24	I	+5 VDC	
25	I	+5 VDC	

2.3.2 Front panel connectors

Table 3 Front panel connectors

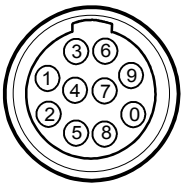
ECG Connector	Pin No	Signal Name
	1 2 3 4 5 6 7 8 9 10 11	R/RA; Right arm electrode C2/V2; Chest electrode C3/V3; Chest electrode L/LA; Left arm electrode N/RL; Neutral/ Right Leg Drive electrode C1/V1; Chest electrode C4/V4; Chest electrode F/LL; Left Leg electrode C6/V6; Chest electrode C5/V5; Chest electrode Cable Shield

SpO_2 connector (SpO_2)



Pin No	Signal
1	Feedback resistor
2	Ground
3	Not Connected
4	Cable shield + probe identification ground
5	Probe identification
6	LED drive ground
7	LED drive current
8	Input signal current
9	Ground
10	Ground

Invasive blood pressure connectors (P1, P2)



Pin No	Signal
1	Pressure +
2	Pressure -
3	Polarisation - (ground)
4	Polarisation +
5	Not connected
6	Not connected
7	Not connected
8	Not connected
9	Ground
10	Cable detection

Temp connector (T1, T2)

Pin No	Signal
1	Temperature probe
2	Temperature probe

2.3.3 Test points on boards

12-lead ECG board

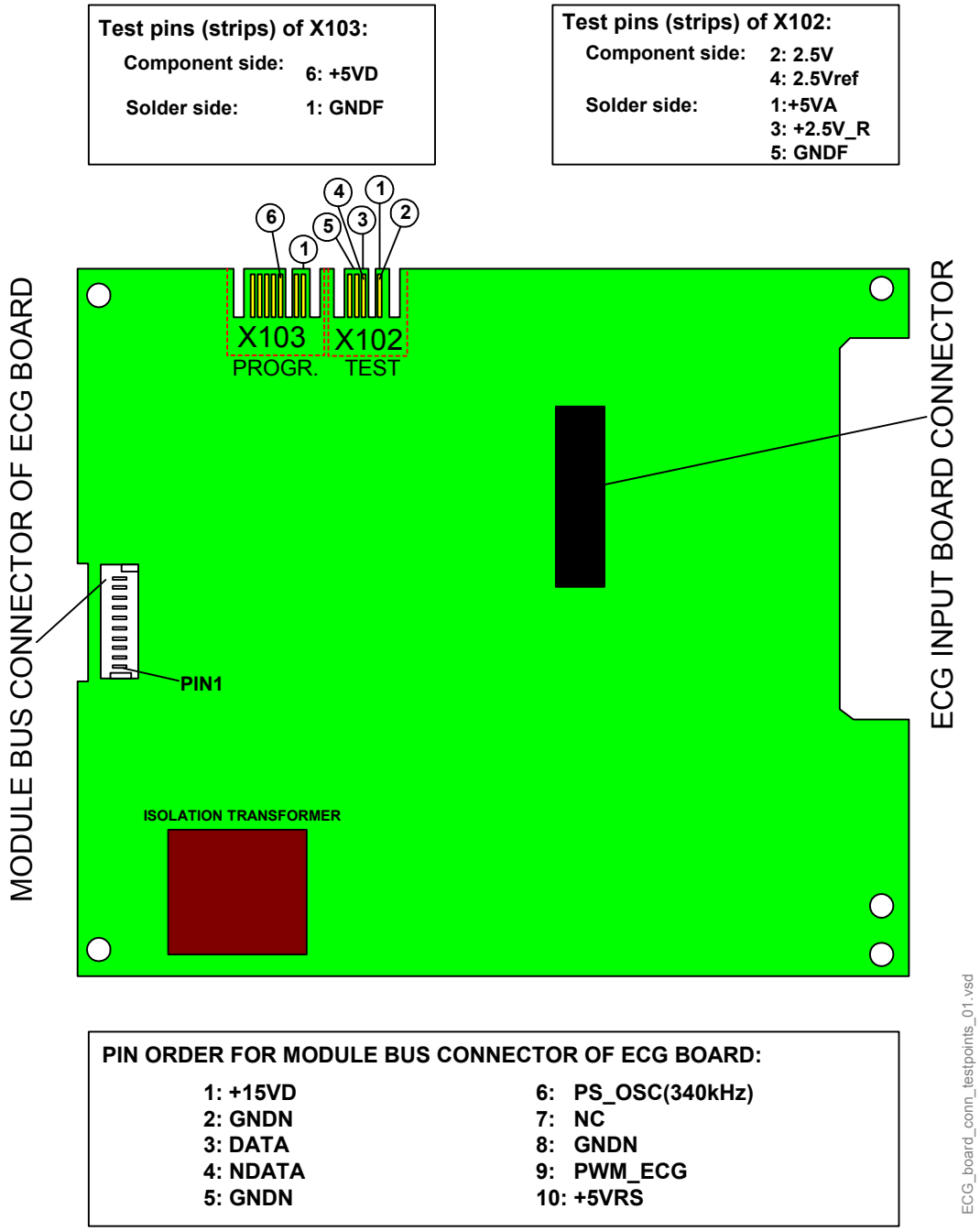


Figure 15 ECG board connectors and test points

NIBP board

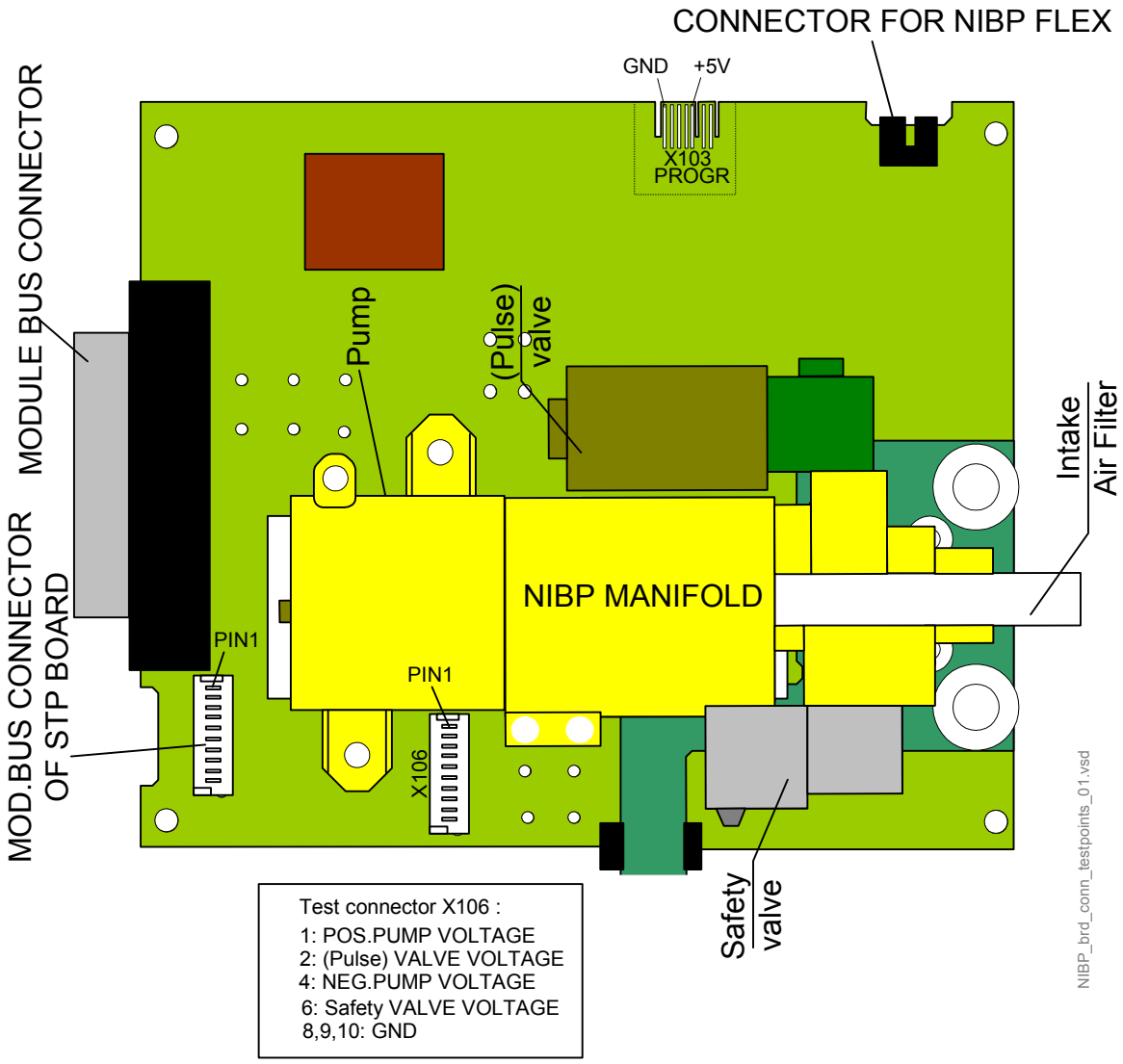
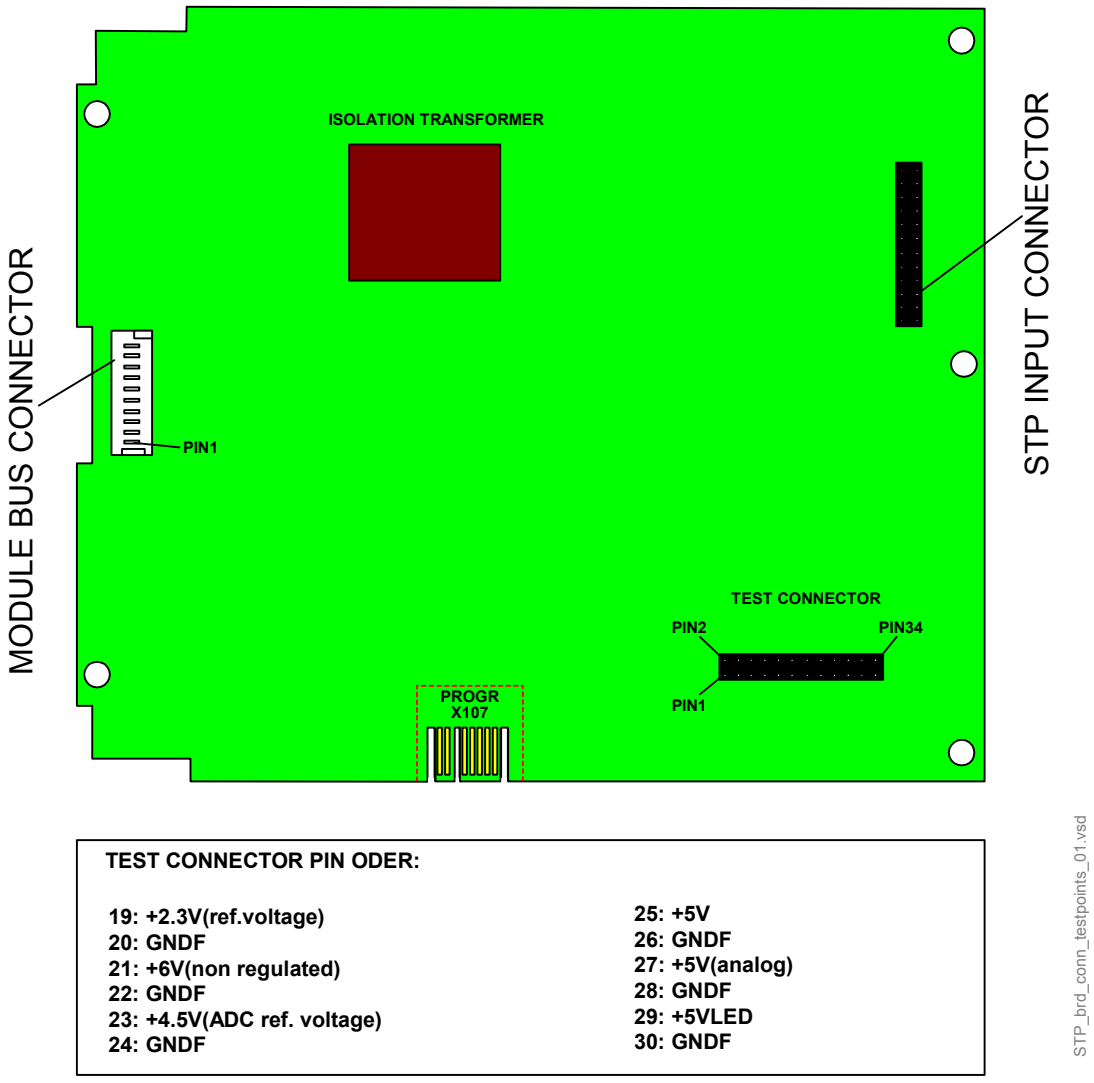


Figure 16 NIBP board connectors and test points

STP board



TEST CONNECTOR PIN ODER:

19: +2.3V(ref.voltage)	25: +5V
20: GNDF	26: GNDF
21: +6V(non regulated)	27: +5V(analog)
22: GNDF	28: GNDF
23: +4.5V(ADC ref. voltage)	29: +5VLED
24: GNDF	30: GNDF

Figure 17 STP board connectors and test points

3 SERVICE PROCEDURES

3.1 General service information

Field service of the hemodynamic modules is limited to replacing faulty printed circuit boards or mechanical parts. Faulty printed circuit boards should be returned to Datex-Ohmeda for repair.

Datex-Ohmeda is always available for service advice. Please provide the unit serial number, full type designation, and a detailed description of the fault.

Only trained personnel with appropriate equipment should perform the tests and repairs outlined in this section. Unauthorized service may void warranty of the unit.

3.2 Service check

These instructions include complete procedures for a service check. The service check should be performed after any service repair; however, the service check procedures can also be used for determining possible failures.

The procedures should be performed in ascending order.

The instructions include a check form , which should be filled in when performing the procedures.

The mark  in the instructions means that the performed procedure should be signed in the check form.

3.2.1 Recommended tools

Tool	Order No.	Notes
Patient simulator	-	
Pressure manometer	-	
Temperature test set	884515	
Multi-link 3-leadwire set		
Multi-Link 5-leadwire set V2-V6		
Multi-Link 5-leadwire set C2-C6		
Multi-Link 12-lead ECG trunk cable		
SpO_2 finger probe	OXY-F4-N or SAS-F4	
InvBP transducer		
Adult NIBP cuff & hose		
Infant NIBP cuff & hose		
Screwdriver		

3.2.2 Recommended parts

Part	Order No.	Notes
NIBP pump filter	57142	

All modules

Detach the module box by removing the two screws from the back of the module. Be careful with loose latch and spring pin for locking.

1. Check internal parts:

– screws are tightened properly

– cables are connected properly

– all IC's that are on sockets are attached properly

– EMC covers are attached properly

– there are no loose objects inside the module

2. Check external parts:

– the front cover and the front panel sticker are intact

– all connectors are intact and are attached properly

– the module box, the latch and the spring pin are intact

3. Replace the NIBP pump filter in PRESTN/RESTN/PRETN modules, if necessary.

- Reattach the module box and check that the latch is moving properly.
- Switch the monitor on and wait until the monitoring screen appears. Configure the monitor screen so that all the needed parameters are shown, for example as follows:

Monitor Setup - ***Waveform Fields*** -

Field 1 - ECG1
Field 2 - ECG2
Field 3 - P1
Field 4 - P2
Field 5 - Pleth
Field 6 - Resp
Digit Fields - Lower Field 2 - NIBP
Lower Field 3 - T1+T2

4. Plug in the module. Check that it goes in smoothly and locks up properly

5. Check that the module is recognized, i.e. all needed parameter information, except invasive blood pressure, starts to show on the screen.

Preset ECG, Respiration, InvBP and SpO_2 measurement settings:

ECG - ***ECG Setup*** - ***Hr Source*** - ***Auto***
Pacemaker - ***Show***

Others - ***Resp Setup*** - ***Size*** - ***1.0***
Resp Rate Source - ***Auto***
Measurement - ***On***
Detection Limit - ***Auto***

Invasive Pressures - ***P1 'Art' Setup*** - ***Label*** - ***Art***
P2 'Cvp' Setup - ***Label*** - ***Cvp***

Pulse Oximetry - ***Pleth Scale*** - ***Auto***

ECG measurement

6. Enter the service menu:

Monitor Setup - ***Install/Service*** (password 16-4-34) -
Service (password 26-23-8) - ***Parameters***

Take down the information regarding module software by selecting ***Scroll Vers*** and turning the ComWheel.

7. Enter the ESTP: ECG service menu:

Check that the 'Timeouts', 'Bad checksums' and 'Bad c-s by mod' values are not increasing faster than by 5 per second. Check also that the ECG/RESP board memories have passed the internal memory test, i.e. the 'RAM', 'ROM' and 'EEPROM' state all OK.

8. Check that the power frequency value is set according to the current mains power frequency. Change the setting by selecting ***Power Freq***, if necessary.

9. Connect a 12-lead ECG trunk cable without a lead set to the module. Check that the message "Leads off" is displayed on the screen.

10. Connect both 5-leadwire sets to the trunk cable. Connect limb lead electrodes and one electrode from the chest lead set to the same potential. Check that the 'Cable type' shows 10 lead.

11. Change the 3-leadwire set to the trunk cable. Check that all the electrodes show OFF in the service menu and the message 'Leads Off' is shown on the screen.

    Connect all the leads together, for example to a suitable screwdriver. Check that all the electrodes show ON and the message 'Asystole' appears.

    Disconnect one of the leads and check that the corresponding electrode in the service menu shows OFF within 10 seconds from the disconnection, and then reconnect the lead. Check the rest of the leads using the same method.

    NOTE: When the ground lead (black) is disconnected all the electrodes should show OFF.

    NOTE: The 'Asystole' and 'Different leads off' messages are shown using certain priority, so even when one of the leads is disconnected, the lead related 'Leads off' message may not appear onto the screen.

    NOTE: When RA, LA or LL electrode is disconnected, all six V electrodes show OFF.

    NOTE: With PRESTN/RESTN/PRETN modules and 5 lead cable the state of V2, V3, V4, V5 and V6 electrodes follow the state of the V electrode.

    Connect the leads to a patient simulator.
    Perform the settings and checks with Dynatech Nevada MedSim 300 Patient Simulator:

    ECG - BASE - BPM - 160
    PACE - WAVE - NSR

    Check that normal ECG waveform is shown, the HR -value is 160 (±5) and the 'Pacer count' -value is not increasing in the service menu.

    ECG - PACE - WAVE - ASNC

    Check that pacemaker spikes are shown on the ECG waveform, the 'HR' -value changes to 75 (±5) and the 'Pacer count' -value is increasing according to shown pacemaker spikes.

    Set the pacemaker option off:

    ECG - PACE - WAVE - NSR

Respiration measurement

12. Check that the 'Resp Available' and 'RESP Measurement' show both ON in the ESTP: ECG service menu.

13. Check the respiration measurement with a patient simulator.

    The settings and checks with Dynatech Nevada MedSim 300 Patient Simulator:

    BASELINE IMPEDANCE -switch - 500
    LEAD SELECT-switch - II/RL-LL

    RESP - WAVE - NORM
    RATE - 20
    OHMS - 1.0
    RATIO - 1/1
    APNEA - OFF
    SHIFT - OFF

    Check that the RESP waveform is shown and the 'RR' -value is 20 (±5). Change the position of the BASELINE IMPEDANCE -switch and check that appropriate RESP waveform and 'RR' -value are shown again within 30 seconds.

    RESP - APNEA - 32 S

    Check that the monitor activates the APNEA -alarm.

    NOTE: Make sure that only the ECG leads are connected to the simulator during the apnea -test. If other cables are connected at the same time, the respiration signal from the simulator may be disturbed, and therefore, the APNEA -alarm may not be activated.

    NOTE: When you have ECG service menu open, spikes will appear on the respiration waveform. These spikes represent the threshold level for detecting inspiration and expiration.

Temperature measurement

14. Enter the ESTP: STP service menu:

    Parameters - ESTP : STP

    Check that the 'Timeouts', 'Bad checksums' and 'Bad c-s by mod' values do not increase faster than by 5 per second. Check also that the STP board memories have passed the internal memory test, i.e. the 'RAM', 'ROM' and 'EEPROM' show all OK.

15. Check that the 'Cable' and 'Probe' show OFF for both channels, T1 and T2, when no probes are connected.

    Connect a temperature test plug into the connector T1. Check that the 'Cable' and 'Probe' for

T1 show ON and the corresponding temperature value appears onto the monitor screen. Perform the same check also for the channel T2.

16. Check the temperature calibrations using temperature test plugs.
If the deviation on a temperature reading on the screen is more than 0.1 °C, calibrate the temperature channels according to the instructions in the chapter 3.4.2 *Temperature calibration*.

17. Activate the temperature test by selecting ***Temp Test*** from the menu and pressing the ComWheel twice. When the message 'Performing temp test' disappears from the digit field, check that no error messages appear and 'Temp error' shows OFF for both channels in the service menu.

18. Check that the module configuration has been set correctly. The configuration in use is shown beside the text 'Configuration' in the service menu and it can be either STP, ST or TP. Change the configuration in the ***Calibrations*** menu, if necessary.

Invasive blood pressure measurement

19. Check the front panel membrane keys that are related to the InvBP measurement.
Press each of the keys at least for one second. Check that the pressed key is identified, i.e. one of the texts for 'Buttons' changes from OFF to ON in the service menu.

20. Check that the 'Cable' and 'Probe' for P1 show OFF. Plug a cable with an invasive blood pressure transducer into the front panel connector P1 and check that the 'Cable' and 'Probe' show ON and the corresponding pressure waveform appears onto the screen.

    Perform the same check also for the InvBP channel P2.

21. Calibrate the InvBP channels P1 and P2 according to the instructions in the chapter. *Invasive pressure calibration*

22. Check the InvBP channels with a patient simulator.

    The settings and checks with Dynatech Nevada MedSim 300 Patient Simulator:

    SENSITIVITY -switch - 5 µV/V/mmHg

    ECG - BASE - BPM - 60 - BP - 1 - WAVE - ATM
    2 - WAVE - ATM

Restore the normal monitoring screen by pressing the key **Normal Screen**.

Connect cables from the channels BP1 and BP2 to the module connectors P1 and P2. Zero the InvBP channels by pressing the keys ZERO P1 and ZERO P2 on the module front panel.

BP - 1 - WAVE - ART
2 - WAVE - CVP

Check that appropriate InvBP waveforms are shown and the InvBP values are approximately 120/80 (±3 mmHg) for the channel P1 and 15/10 (±2 mmHg) for the channel P2.

Check that HR- value is calculated from P1 when ECG is not measured (ECG cable disconnected).

SpO_2 measurement

23. Check that the message 'No probe' is shown when no SpO_2 sensor is connected to the module. Connect a SpO_2 finger probe to the module. Check that the message 'Probe off' is shown when the probe is not connected to a finger.

24. Connect the SpO_2 probe onto your finger. Check that the reading of 95-99 and SpO_2 waveform appears. Check that HR- value is calculated from SpO_2 when ECG and InvBP (P1) are not measured.

Non Invasive Blood Pressure measurement

25. Enter the NIBP module service menu:
Parameters - NIBP

Check that the 'Timeouts', 'Bad checksums' and 'Bad c-s by mod' values are not increasing faster than by 5 per second. Check also that the NIBP board memories have passed the internal memory test, i.e. the 'RAM', 'ROM' and 'EEPROM' show all OK.

26. Check the front panel membrane keys.

Select ***Buttons/Leds***.

Press each of the two NIBP related membrane keys at least for one second. Check that the pressed key is identified, i.e. the corresponding text changes from OFF to ON in the menu when the key is released back up again.

27. Check the pump and valves.

Highlight ***Pneumatics*** from the NIBP menu. Connect a pressure manometer to the NIBP

module cuff connector.

Select ***Start Pump*** and press the ComWheel. Check that the pump turns on and the pressure inside the tubing system starts to increase. Stop the pump by pressing the ComWheel again when the pressure reaches 280 mmHg.

Highlight ***Open Exh2***. Press the ComWheel and check that the pressure inside the tubing system starts to drop then press the ComWheel again. If necessary, turn the pump on again for a moment to increase the pressure inside the tubing system.

Highlight ***Set Valve***. Press the ComWheel and set the value under the text 'Pulse Valve' to number 150 by turning the ComWheel. Press the ComWheel again and check that the pressure inside the tubing system starts to drop. Finish the test by selecting ***Previous Menu***.

28. Check the NIBP tubing system for leakages.

    Select ***Calibrations*** from the NIBP service menu.

    Connect the pressure manometer to the NIBP module cuff connector. Start the active leak test from the menu by pressing the ComWheel. The module pumps a pressure of about 265 mmHg and then the pump stops.
    Wait for 15 seconds for the pressure to stabilize then check that the pressure does not drop more than 6 mmHg per one minute. Release the pressure by pressing the ComWheel once more.

29. Calibration check.

    Recalibrate the NIBP measurement. Remember to set the calibration protection back on after the calibration.

    Disconnect the pressure manometer. Select ***Calibrations*** and then highlight ***Calibration Check***. Press the ComWheel and take down the zero offset values for both pressure transducers, B1 and B2. The values should be within ±20 mmHg.

    Connect the pressure manometer to the cuff connector and check the calibration with pressures 100 mmHg, 200 mmHg and 260 mmHg. The zero offset value must be added to the displayed pressure value in order to determine the real pressure.

30. Check the safety valve.

    Select ***Safety Valve*** from the NIBP service menu.
    Keep the pressure manometer connected to the cuff connector.

    NOTE: Make sure your pressure manometer can be used to measure pressures over 300 mmHg. If such a pressure manometer is not available, perform the check with an adult cuff that is connected around some round object, for example a calibration gas bottle.

    Highlight ***Start Test***. Start the adult safety valve test by pressing the ComWheel. Wait until

the pump stops and the pressure is deflated. Check the pressure values 'Max press' and '2 s after stop' for both transducers. All the values should be within 270 - 330 mmHg.

Highlight ***ADULT***. Press the ComWheel and check that the text changes now to ***INFANT***. Select ***Start Test*** and wait until the pump stops and the pressure values on the screen have been updated. Check that the values 'Max press' and '2 s after stop' are all now within 135 to 165 mmHg.

Return to the normal monitoring mode by pressing **Normal Screen**.

31. Connect an adult NIBP cuff to the cuff connector and disconnect one of its hoses.
Start NIBP measurement by pressing the key **Start/Cancel** on the module and check that the message 'Cuff loose' appears on the screen within 70 seconds.
Reconnect the hose and then bend it with your fingers. Restart the measurement and check that the message 'Cuff occlusion' appears on the screen within 70 seconds.

32. Check that automatic inflation limits are in use:

NIBP - ***NIBP Setup - Inflation Limits - Auto - Previous Menu***

Connect the cuff onto your arm, highlight ***Start Ven.Stasis*** in the NIBP menu and press the ComWheel. Check the module identifies the cuff, i.e. the text 'Adult' appears into the NIBP digit field for a short moment.

Keep the pressure inside the cuff for about half a minute in order to find out that the cuff is not leaking, then press the ComWheel again. Select **Normal Screen**.

33. Keep the cuff on your arm and perform one NIBP measurement. Check that the module gives a reasonable measuring result.

34. Connect an infant cuff to cuff connector and wrap it around your fingers.
Start NIBP measurement and check that the module identifies the cuff, i.e. the text 'Infant' appears into the NIBP digit field. Cancel the measurement after the cuff identification.

All modules

35. Perform electrical safety check and leakage current test.

36. Check that the module functions normally after the performed electrical safety check.

37. Clean the module with suitable detergent.

- Fill in all necessary documents.

3.3 Disassembly and reassembly

CAUTION When reassembling the module, make sure that all cables are reconnected properly.

3.3.1 M-PRESTN/-RESTN/-PRETN modules

Disassemble the M-PRESTN/-RESTN/-PRETN module in the following way. See the exploded view of the module in chapter 6.1.1.

1. Remove the two screws from the back of the module.
2. Pull the module box slowly rearwards and detach it from the main body. Be careful with loose latch and spring pin for locking.
3. To detach the ECG board, detach four screws, disconnect ribbon cable from the STP board (supply voltage), and ribbon cable from the ECG input board.
4. When the ECG board is removed, the STP board can be detached by removing four screws, disconnecting the cable from the membrane keypad, the cable from the temperature connectors, and cables from the SP input board. Also disconnect the NIBP hoses and the ribbon cable from the NIBP board.
5. When the ECG board and the STP board are removed, the NIBP board can be detached by removing four screws. Disconnect the hoses from the pressure transducers and the pump. If the filter for the air inlet of the pump is removed, it must be replaced.

3.4 Adjustments and calibrations

3.4.1 NIBP calibrations

The electronics of the NIBP pressure measurement is calibrated at the factory. The processor automatically maintains the zeroing pressure. If the zero point of the pressure transducer drifts more than specified, an error message is given and the NIBP board should be recalibrated or replaced.

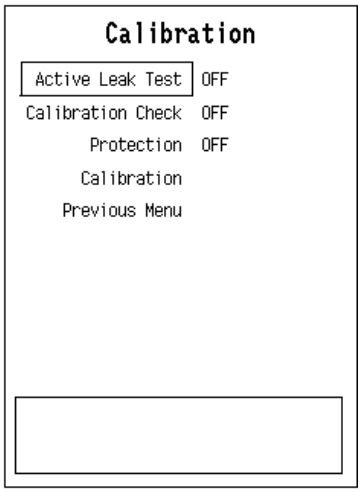
Recalibrate the NIBP measurement once a year. The checking and recalibrating can be done in the NIBP service menu.

The calibration of the primary pressure channel can also be checked from the NIBP setup menu (***NIBP - NIBP Setup - Calibration Check***). In this case the auto zeroing is performed at start - remove hose before entering to ensure atmospheric pressure to the pressure transducers - the primary pressure is displayed. The zero-offset value should then be zero.

Check the intake air filter as part of the calibration check. Change the filter if it is visibly dirty.

Calibration check

1. Enter ***Calibration*** menu.



2. Select ***Calibration Check*** and press the ComWheel.
3. Connect an external precision manometer to the module.

4. Pump the following pressures to manometer and check the difference between the manometer and monitor pressure display (The zeroing offset is automatically subtracted from the pressure readings).

Table 4 NIBP calibration check pressures

Pressure	Max. error	Example
0 mmHg	±5 mmHg (=zero offset)	-1
100 mmHg	100 ±2 mmHg	100 ±2
200 mmHg	200 ±3 mmHg	200 ±3

If the error of pressure channel B1 is larger than specified above, the module should be recalibrated. The error of B2 is allowed to be even twice as large because it has no effect on blood pressure measurement accuracy. However, we recommend recalibrating the module when the error of B2 is larger than specified above to ensure best possible operation.

Calibration

1. Enter ***Calibration*** menu.
2. Remove hoses from front panel connector to enable proper zeroing.
3. Select ***Calibration***. If it is not available, perform the steps A, B, and C.

NOTE: Do not pull out the NIBP module from the monitor frame. The module must be in the frame during the whole procedure.

A. Press NIBP module buttons **Auto ON/OFF** and **Start Cancel** simultaneously for 3 seconds to enable the calibration. This enables menu selection ***Protection***. The message 'Calibration switch ON!' appears.

B. Select ***Protection OFF*** in the Calibration menu and press the ComWheel.

C. Press the buttons again for 3 seconds. Menu selection ***Calibration*** is now enabled, and ***Protection*** is disabled. When the calibration is enabled, a message 'Calibration not protected' appears.

- Start Calibration by pressing the ComWheel. Messages 'Zeroing' and 'Zeroed' will appear in the NIBP message field. After this a pressure bar and text 'Calibrating' will appear.
- Connect an external mercury manometer with pump to module through the both tubes of the hose - both transducers B1 and B2 must be calibrated simultaneously. Pump up to a pressure about 200 mmHg according to the manometer. Calibration is possible in the range 150 to 250 mmHg.
- Verify that both pressure values in the prompt field match the manometer reading. If not, adjust by turning the ComWheel. When the values of the pressure bar and the manometer are equal, press the ComWheel to confirm the calibration. The message 'Calibrated' will appear onto the NIBP digit field after a few seconds, which means that the calibration succeeded, and the new calibration data is saved in EEPROM.

NOTE: When calibrating NIBP, always change the displayed pressure value slightly with the ComWheel, even in cases where the value would be correct. For example change the value one step higher and then back one step lower. "Calibrated" text should appear in the display. This ensures that the calibration procedure is correctly registered and stored by the module.

- To set the protection on:
  Press NIBP module buttons **Auto ON/OFF** and **Start Cancel** simultaneously for 3 seconds. Select ***Protection ON*** and push the ComWheel. Then press the buttons again for three seconds.
- Remove the module from the frame and plug it back again. Then perform *Calibration check* (see the preceding page) to verify the new calibration.

3.4.2 Temperature calibration

NOTE: For the temperature calibration, separate, accurate test plugs (25 °C and 45 °C) are needed. A test set of two plugs is available from Datex-Ohmeda, order code 884515.

Calibrate the temperature when measured test values differ for more than ±0.1 °C, and always after STP board replacement.

1. Enter ESTPR: STP service menu.
2. Enter ***Calibrations*** menu.
3. Choose ***Protection OFF*** in protect mode.
4. Select ***Calibrate T1/Calibrate T2***.
5. Insert calibration plug (25 °C) into T1/T2 connector.
6. Press the ComWheel.
7. Insert calibration plug (45 °C) into T1/T2 connector.
8. Press the ComWheel.
9. Choose ***Protection ON*** in protect mode.

3.4.3 Invasive pressure calibration

Calibrate invasive pressure when the pressure transducer (probe) is replaced with a different type of transducer, and when STP board is replaced.

1. Enter ESTPR: the STP service menu.
   (**Monitor Setup**, ***Install/Service*** (password 16-4-34), ***Service*** (password 26-23-8), ***Parameters***).
2. Enter ***Calibrations*** menu.
3. Connect a pressure transducer with a pressure manometer to the P1/P2 connector. Choose ***Calibrate P1*** or ***Calibrate P2***. Leave the transducer to room air pressure.
4. Press the ComWheel to start zeroing.
5. Supply a pressure of 100 mmHg to 300 mmHg to the transducer. The recommended pressure is 200 mmHg.
6. Set the pressure on the display to match the pressure reading on the manometer and press the ComWheel. A tolerance of ±1 mmHg is allowed.
7. The message ‘Calibrated’ will appear on the display.

4 TROUBLESHOOTING

4.1 Troubleshooting charts

See also the *User's Reference Manual* for more troubleshooting procedures.

4.1.1 NIBP

TROUBLE	CAUSE	TREATMENT
No NIBP value displayed	NIBP not selected on screen.	Check monitor setup.
NIBP menu fading	No M-PRESTN module, module not properly connected, or NIBP and PRESTN module connected at the same time.	Plug in the module.
Artifacts-message	Unsuccessful measurement due to patient movement, shivering, external artifact or weak signal.	
Weak pulsation-message	Weak or unstable oscillation pulses due to: • artifacts • weak pulse pressure due to arrhythmias • improper cuff position or attachment • too few pulses detected • weak or unusual blood circulation • obese subject	Check patient condition and retry. Check any leaks and retry. Use proper size of cuff. Check attachment.
Call service Error X-message	NIBP hardware error. X = error number.	See the description of the error message code in 4.1.2, the causes and the solutions listed in the next chapter.

TROUBLE	CAUSE	TREATMENT
Cuff loose-message	1. Hose and/or cuff not connected.	1. Connect the hose and the cuff.
	2. Hose and cuff connected. Reasons:	
	– cuff loosely wrapped	– tighten the cuff
	– leakage in cuff or hose	– replace cuff/hose
	– leakage inside module	– check internal tubing and air chamber, and fix if necessary
	– pump does not work	– check pump connector; if OK, replace pump
Air leakage-message	1. Hose or cuff leaking. Reasons:	1. Replace cuff
	– cuff damaged	– replace cuff
	– cuff connector damaged	– replace cuff connector (if the fault is in hose connector,)
	– O-ring damaged or missing	– replace O-ring
	– hose double connector damaged	– replace hose
	2. Hose and cuff OK. Reasons:	2. Connect or replace tube
	– leakage inside the module	– replace the whole tubing
	– tube disconnected or damaged	– fix connections
	– tubes or valve(s) damaged	– replace tubes/valve(s)
Unable to measure Sys-message	Systolic blood pressure probably higher than the inflation pressure or artifacts.	Automatic retrial with increased pressure.

TROUBLE	CAUSE	TREATMENT
Cuff occlusion-message	1. Cuff and/or hose occluded. Reason:	
	– cuff tube kinked	– straighten tube
	– tube inside module kinked	– straighten tube
	– occlusion inside/outside module	– remove occlusion
	2. Cuff, hose, and tubes OK. Reason:	
	– fault in pressure transducer	– replace the NIBP board
	– fault in A/D converter	– replace the NIBP board
	– faulty calibration	– check calibration
Calibration switch on – message	EEPROM protection has been handled by pressing module buttons **Auto ON/OFF** and Start **Cancel** simultaneously for 3 seconds.	Enables setting the protection OFF in the Calibration menu. Press the buttons again if you are not going to calibrate.
Calibration not protected - message.	Calibration protection is set to OFF.	Set the protection ON in the NIBP Calibration menu.

4.1.2 NIBP error code explanation

Code	Explanation	Treatment
0	RAM failure; memory failure	Change the NIBP board.
1	ROM checksum error; memory failure	Change the NIBP board.
2	Pump current failure	Check short circuits. Change the NIBP board.
3	Safety CPU internal test failure or pressure sensor reference voltage failure	Change the NIBP board.
4	EEPROM protection error	Press module buttons **Auto ON/OFF** and Start **Cancel** simultaneously for 3 seconds.
5	Calibration not protected	Protect calibration by selecting Protection ON in the NIBP calibration menu.
6	Pressure sensors give different readings	Try to remeasure, if the problem persists recalibrate. If the problem still persists change the NIPB board.
7	Calibration failure	Reset module and recalibrate. If this does not help, change the NIBP board.
8	Exhaust Valve occlusion	Check tubing. If this does not help, change the NIBP board.
9	Measurement related SW error	Automatic recovery.
10	EEPROM checksum error; memory failure	Change the NIBP board.
11	Auto zero range exceeded	Calibrate the NIBP.
12	Communication break; temporal break down of communication from monitor detected	Automatic recovery.
13	Illegal neonate cuff with identifying magnet connected	Remove the cuff.
14	-	
15	Safety CPU pressure calibration error	Recalibrate. If this does not help, change NIBP board.
16	Communication error between CPUs	Change NIBP board.
17	Safety CPU has cut down power from pneumatics due to repeating safety limit violations	Reset module. If problem persists change NIBP board.

4.1.3 ECG

TROUBLE	CAUSE	TREATMENT
HR numerical display shows '---'	No heart rate available.	If no ECG waveform, check LEADS OFF message and connect the leads.
		If ECG waveform exists, check heart rate source e.g. in the ECG Setup menu behind ECG key.
Unacceptable ECG waveform	Poor electrode or poor electrode skin contact.	Electrodes from different manufacturers are used. /Too much/little gel is used.
	Poor electrode condition.	Electrodes are dried out.
	Improper site of electrodes.	Check that electrodes are not placed over bones, active muscles, or layers of fat.
	Improper skin preparation.	Remove body hair. Clean attachment site carefully with alcohol.
	Improper bandwidth filter.	Check filter.
No ECG trace	Waveform not selected on screen.	Press the **Monitor Setup** key and make adjustments.
	Module not plugged in correctly.	Plug in.
Noise-message	High frequency or 50/60 Hz noise.	Isolate noise source.

4.1.4 Pulse oximetry (SpO_2)

TROUBLE	CAUSE	TREATMENT
Message 'NO PROBE'	No probe connected to the monitor.	Check probe connections.
	Probe faulty.	Change the probe.
Message 'PROBE OFF' though probe properly attached to the patient	Unsuitable site.	Try another site.
	Probe faulty.	Try another probe.
	Probe connection cable not connected to probe.	Connect the cable to probe.
Finger probe falls off	1. Probe is slippery.	1. Wipe with 70 % isopropyl alcohol and allow drying.
	2. Finger is too thin or thick.	2. Try other fingers, or other probe types.
Weak signal artifacts	Poor perfusion.	Try another place.

TROUBLE	CAUSE	TREATMENT
	Movement artifacts.	
	Shivering.	
Message 'NO PULSE'	Pulse search > 20 sec. and low SpO_2 or low pulse rate.	Try other fingers.
Message 'ARTIFACT'	Pulse modulation exceeds the present scale.	Try another place or another probe.
Message 'CHECK PROBE'	DC value not in balance.	Try another probe.
Message 'POOR SIGNAL'	Poor perfusion. Modulation (Red or Ired) < 0.25 %	Check that the sensor is positioned correctly to the patient.
Message 'FAULTY PROBE'	Probe is faulty.	Change the probe.
No SpO_2	No waveform selected on screen.	Check selected SpO_2 waveforms by pressing **Monitor Setup** key and selecting ***Modify waveforms***.
	Wrong configuration setting.	Check the configuration settings from the ESTPR:STP/Calibrations menu (**Monitor Setup** - ***Install/Service*** - ***Service*** - ***Parameters***)

4.1.5 Temperature

TROUBLE	CAUSE	TREATMENT
Message 'TEMPERATURE ERROR'	Faulty calibration.	Perform calibration. If it does not help, check that front panel connector is properly connected to STP board.
No temperature displayed	Wrong type of probe.	Use correct probe.
	Temperature out of measurable range.	The range is between 10 and 45 °C.
	Temperature calibration not protected.	Set the protection ON in the Service Menu.

4.1.6 Invasive blood pressure

TROUBLE	CAUSE	TREATMENT
Abnormally low pressure	Transducer wrongly positioned.	Check mid-heart level and reposition transducer.
No pressure	Defective transducer.	Check transducer.
	No pressure module plugged in.	Check the module.
	No waveform selected on screen.	Check selected pressure waveforms by pressing Monitor Setup key and selecting modify waveforms.
		Check that pressure transducer is open to patient.
	Wrong configuration setting	Check the configuration setting from the ESTP:STP/Calibrations menu (**Monitor Setup** - ***Install/Service*** - ***Service*** - ***Parameters***)
Not zeroed -message	Measurement on, channel not zeroed.	Zero the channel.
Zeroing failed -message	Unsuccessful zeroing of P1 /P2 (number field).	Possibly due to pulsating pressure waveform. Open the transducer to air and zero the channel.
		Offset is > 150 mmHg. Open the transducer to air and zero the channel.
		Defective transducer. Replace it and zero the channel.
Calibration failed -message	Unsuccessful calibrating of P1/P2 (number field), possibly due to pulsating waveform	Turn the transducer to sphygmomanometer and try again (zeroing takes place first).
		Gain is beyond the limits (± 20 % of the default gain). Replace the transducer.
Out of range < 40 mmHg	Measurement pressure is beyond measurement range.	Check transducer level. Zero the channel.
Out of range > 320 mmHg	Measurement pressure is beyond measurement range.	Check transducer level. Zero the channel. The patient may also have high pressure.
Zero adj. > 100 mmHg	Offset when zeroing is > 100 mmHg (but < 150 mmHg) from the absolute zero of the module (with default gain).	Check transducer. The waveform may hit the top and the numeric display not shown.

TROUBLE	CAUSE	TREATMENT
Out of range	Measured pressure is beyond the internal measurement range of the module.	The waveform hits the top and the numeric display not shown. Check transducer and its level. Zero the channel.

4.1.7 Impedance respiration

TROUBLE	CAUSE	TREATMENT
No resp trace	Waveform not selected on the screen	Press the Monitor Setup key and make adjustments.
	Module not plugged in correctly	Re-plug the module.
Unacceptable resp waveform	Poor electrode or poor electrode skin contact	Electrodes from different manufacturers are used. Too much/little gel is used.
	Poor electrode condition	Electrodes are dried out.
	Improper site of electrodes	Check that electrodes are not placed over bones, active muscles, or layers of fat.
	Improper skin preparation	Remove body hair. Clean attachment site carefully with alcohol.
Message: 'SMALL RESP CURVE'	Respiration signal is very small	With 3-lead cable in ESTPR/NESTPR try another lead connection I, II, III or try 5-lead cable.
Message: 'APNEA ALARM', and respiration waveform normal	Respiration source is CO_2	Check respiration source and change it to correct one.

4.2 Troubleshooting flowcharts

4.2.1 M-PRESTN module troubleshooting for NIBP parameter

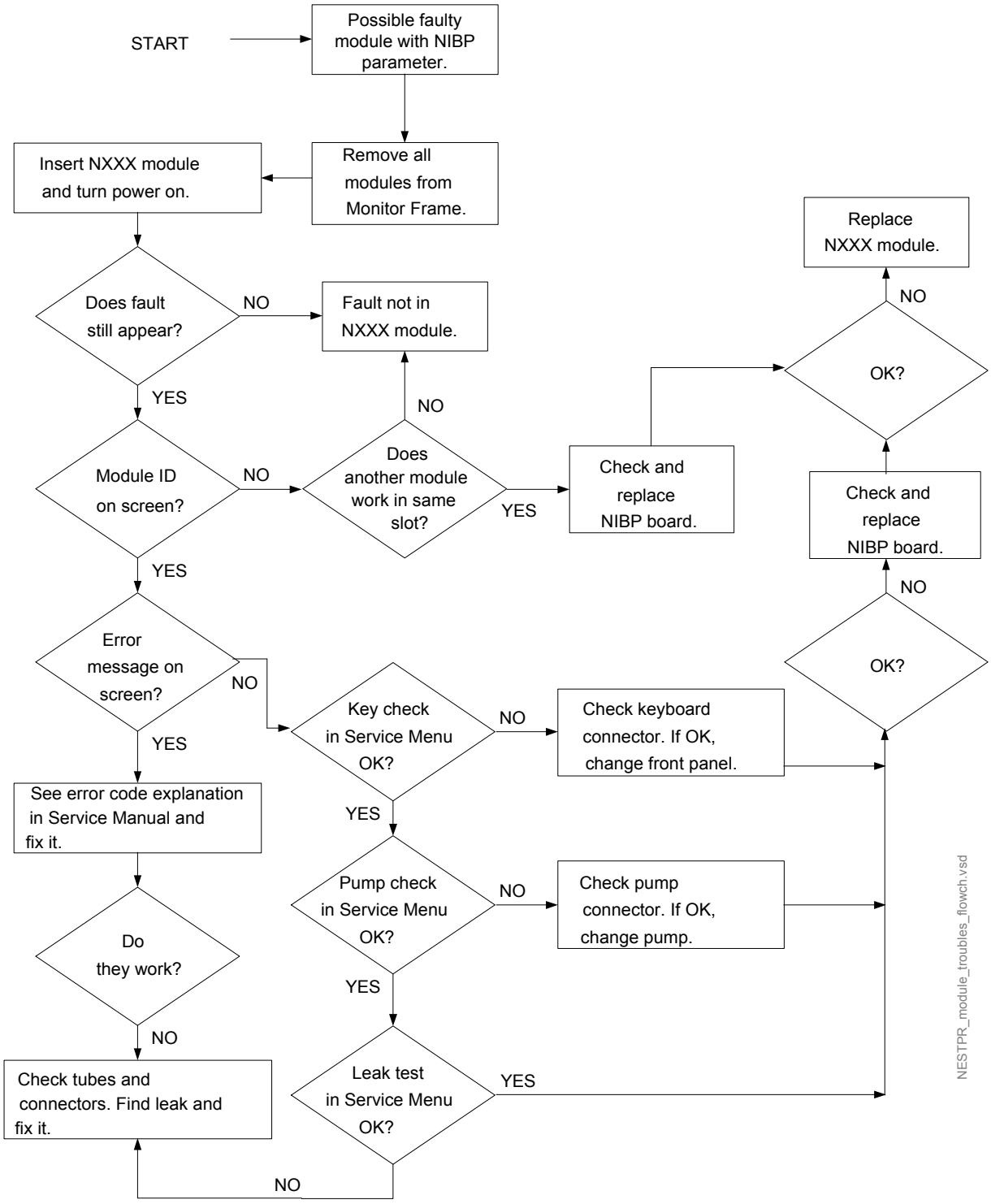


Figure 18 M-PRESTN module troubleshooting flowchart for NIBP Parameter

4.2.2 M-PRESTN module troubleshooting for parameters ESTPR

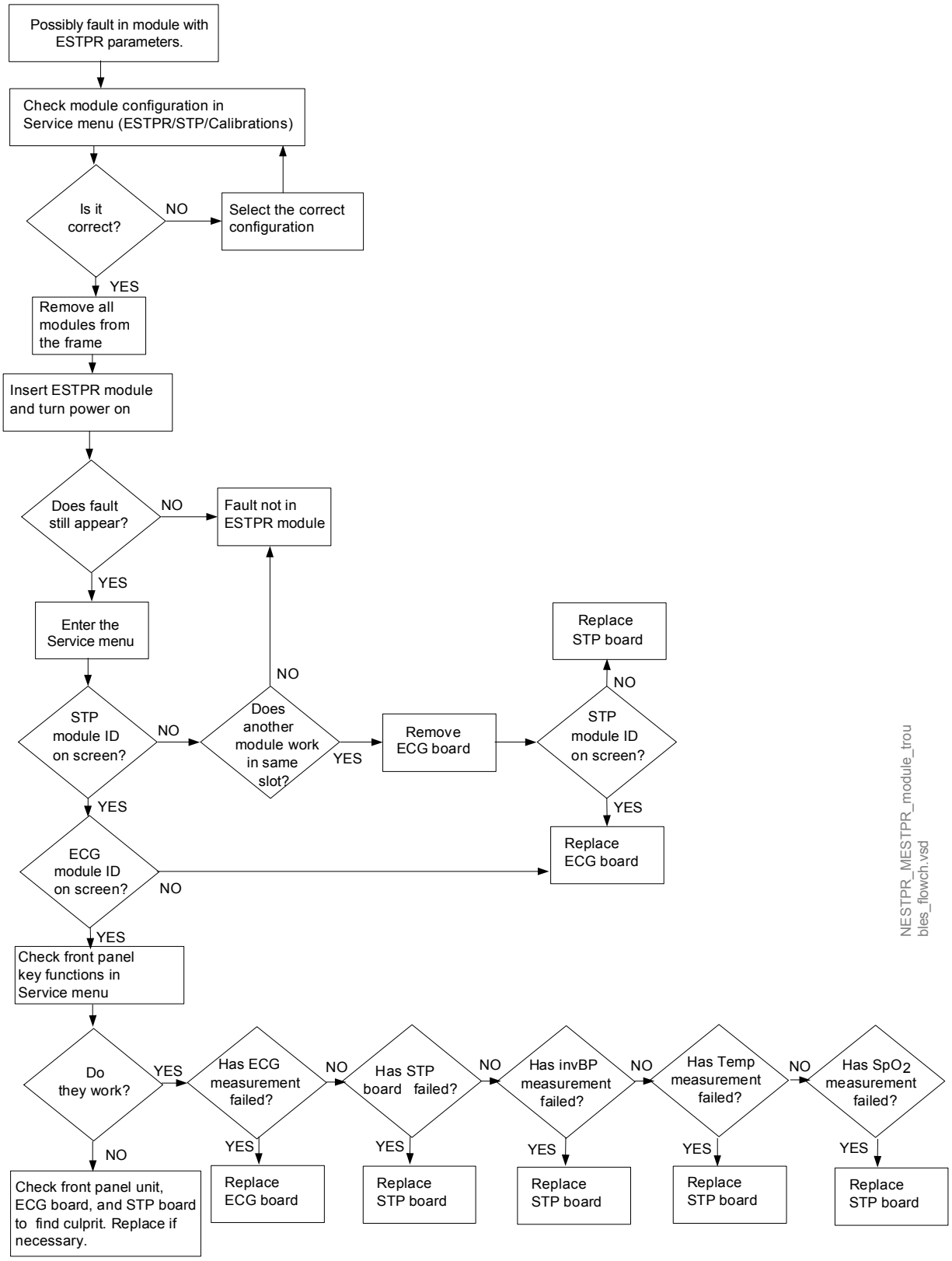
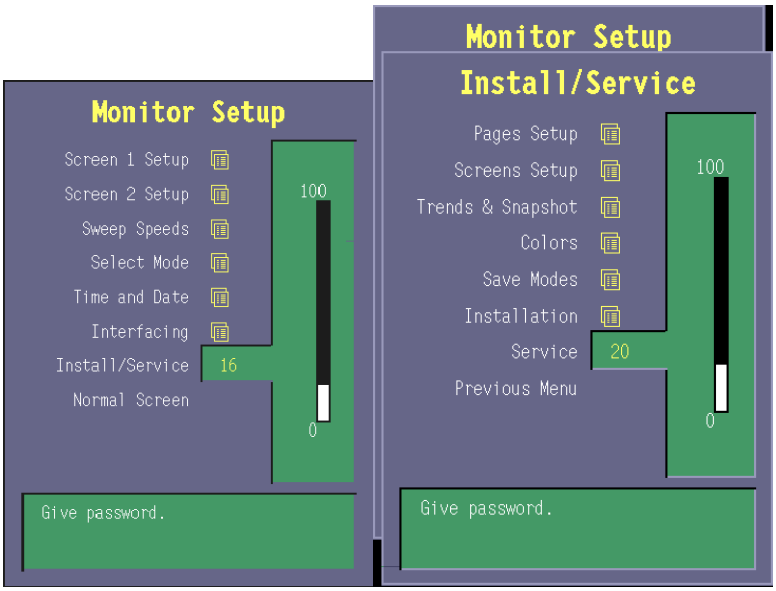


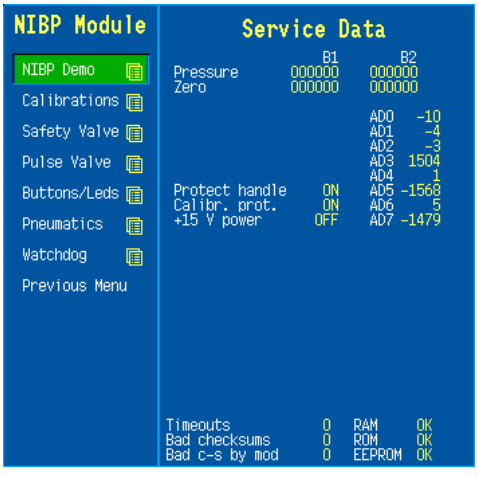
Figure 19 M-PRESTN Module Troubleshooting Flowchart for Parameters ESTPR

5 SERVICE MENU

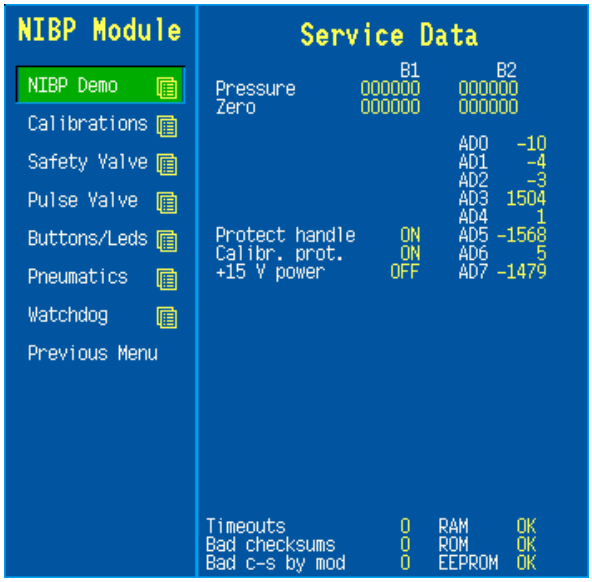


1. Press the **Monitor Setup** key.
2. Select ***Install/Service*** (password 16-4-34).
3. Select ***Service*** (password 26-23-8).
4. Select ***Parameters - NIBP***.

NOTE: Parameter values in Service Data fields are for reference only on this chapter.



5.1 NIBP service menu



Service Data

Pressure shows measured pressure multiplied by 10. This value is automatically zero-drift compensated.
Zero shows difference between zeroing value in the permanent memory (stored when module is calibrated) and the current automatic zero-drift compensation multiplied by 10. The value can change between +20 and -20 mmHg. If the zero drift exceeds ± 10 mmHg, the module should be recalibrated.

Protect handle indicates hardware protection for EEPROM memory. It should be ON all the time in normal operation. If it is OFF data can not be read from or written to EEPROM, only the calibration protection can be set or reset by software. It can be turned to OFF by pressing NIBP module buttons **Auto ON/OFF** and **Start Cancel** simultaneously for 3 seconds, which also enables ***Protection ON/OFF*** menu selection in the calibration menu.
Calibr. prot. shows software calibration protection and it should be OFF to enable calibration.

+15 V power refers to legacy NIBP modules. Not used in M-PRESTN/M-RESTN/M-PRETN.

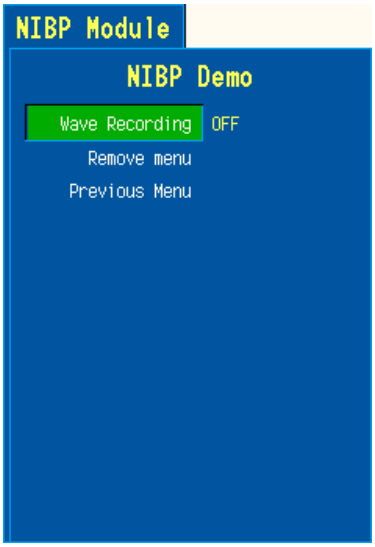
AD0 to **AD7** show the values of each eight channels of A/D converter. AD7 is not used in M-PRESTN/M-RESTN/M-PRETN.

Timeouts is a cumulative number that indicates how many times the module has not responded to the monitor's inquiry. **Bad checksums** is a cumulative number that indicates how many times communication from the module to monitor broke down.
Bad c-s by mod is a cumulative number that indicates how many communication errors the module has detected.
The monitor starts counting these items at power up and resets to zero at power off. The nonzero values do not indicate a failure, but the continuous counting (more than 5 per second) indicates either serial communication failure, or module not in place. Also other modules can cause communication errors that cause these numbers rise.

RAM indicates the state of the RAM memory.
ROM indicates whether the checksum in the EPROM is in accordance with the one the software has

calculated.
EEPROM indicates if the values stored in the permanent memory are valid.
The state is either **OK, Fail** or **?** (module not in place or a communication error).

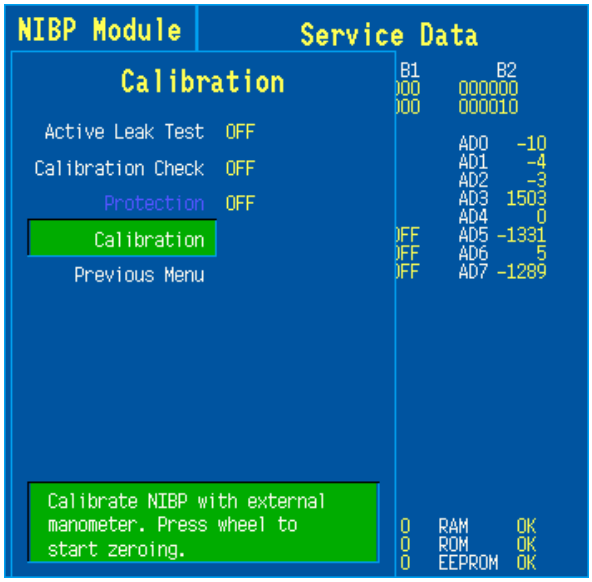
5.1.2 NIBP demo menu



A service menu for demonstrating the oscillometric method of NIBP measurement. The menu shows the real-time pressure signals that are measured from the NIBP cuff. The measurement result is shown in the adjoining digit field.

Wave Recording	**Wave Recording** is for selecting the recording option. If ON is selected, the pressure signals are recorded in real-time onto the M-REC paper.
Remove menu	**Remove menu** widens the displayed waveform area.
Previous Menu	The menu can be closed by selecting the **Previous Menu** or just by pressing the ComWheel if the **Remove menu** was selected.

5.1.3 NIBP calibration menu



Active Leak Test Wrap an adult cuff around a pipe and connect the cuff to the module. Select the active leak test (ON). The module automatically pumps a pressure of 260 mmHg into the cuff. Wait for several seconds until the pressure stabilizes. Then check that the pressure reading does not drop more than 6 mmHg per minute. If it does, leaking point(s) should be detected and fixed. Cancel the test by selecting Active leak test OFF.

Calibration Check

After the calibration check is selected (ON), the module zeroes the pressure transducers at the beginning of the calibration check. Do not pump pressure until the text 'Calibrating' appears to the NIBP digit field or the zeroing will fail. After zeroing is done, manually pump pressure into the module and make sure that the same pressure values are shown both on the display and on the manometer. Pressure of both pressure channels B1 and B2 are shown. Note difference to the legacy modules with NIBP. The pressure values are automatically zero-compensated, so the readings of B1 and B2 should be the same as the manometer readings.

Protection Software calibration protection (ON/OFF). Select OFF when calibrating. **Protection** selection becomes available in the menu after pressing NIBP module buttons **Auto ON/OFF** and **Start Cancel** simultaneously for 3 seconds.

Calibration Calibration selection is available only when protection is OFF and module buttons **Auto ON/OFF** and **Start Cancel** are pressed simultaneously for 3 seconds.

NIBP calibration can be performed in the NIBP Service menu as follows:

NOTE: Both channels B1 and B2 must be calibrated simultaneously.

1. If **Protection** is ON change it to OFF by pressing NIBP module buttons **Auto ON/OFF** and **Start Cancel** simultaneously for 3 seconds, which enables the **Protection** selection. Then press the buttons again for 3 seconds to enable **Calibration**.

NOTE: The module must be in the frame during the whole procedure.

NOTE: When the buttons have been pressed, the NIBP field shows an error message 'Calibration switch on!'.

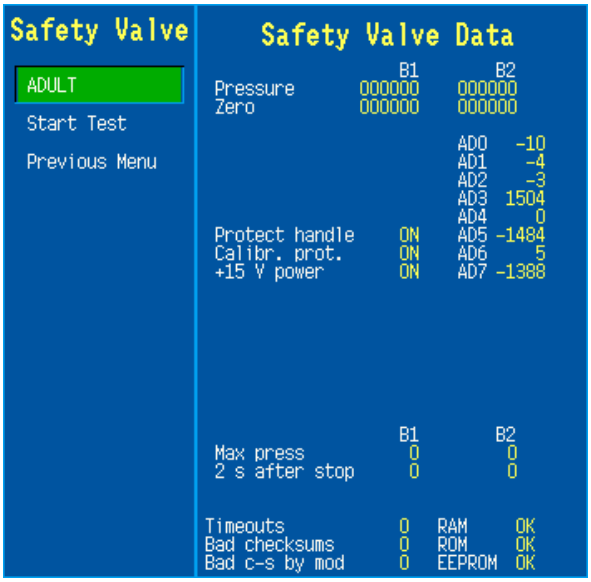
NOTE: When calibration is enabled, a message 'Calibration not protected' appears.

2. For proper zeroing to take place, remove the hose from the front panel connector. Select ***Calibration*** and push the ComWheel. Messages 'Zeroing' and 'Zeroed' will appear in the NIBP message field. After this a pressure bar will appear beside the menu and the text 'Calibrating' will appear to NIBP digit field.
3. Connect an external mercury manometer with pump to module through the both tubes of the hose. Pump up to about 200 mmHg pressure (range of 150 to 300 mmHg allowed) according to the manometer. Verify that both pressure values in the prompt field match the manometer reading. If not, adjust by turning the ComWheel.
4. When the values are equal, push the ComWheel to confirm the calibration. After a few seconds 'Calibrated' message will appear to the NIBP digit field, which means that the calibration data has now been saved.

NOTE: When calibrating NIBP, always change the displayed pressure value slightly with the ComWheel, even in cases where the value would be correct. For example change the value one step higher and then back one step lower. "Calibrated" text should appear in the display. This ensures that the calibration procedure is correctly registered and stored by the module.

5. Use the module buttons again to enable **Protection** setting and set it ON, and finally disable **Protection** setting.

5.1.4 NIBP safety valve menu



Start Test **Start test** is for starting and **Stop test** is for stopping the Safety Valve test.

Safety Valve Data

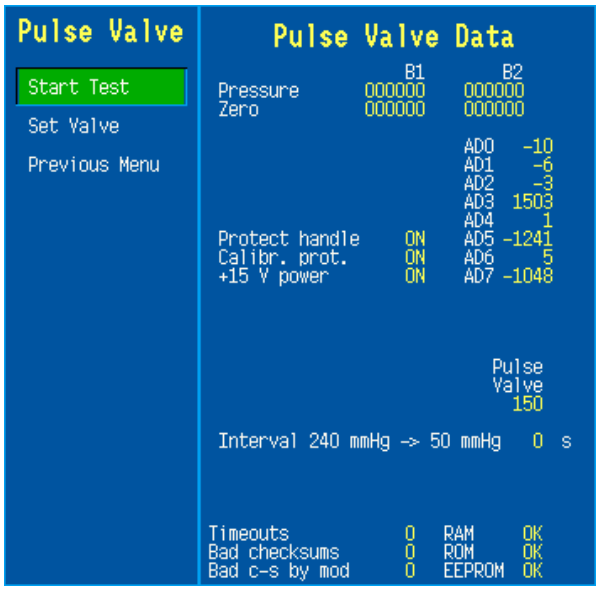
See NIBP Service menu in chapter 5.1 for information on general items **Pressure, Zero, Protect handle, Calibr. prot., +15 V power, AD0** to **AD7** as well as **Timeouts** etc.

Max. press and **2 s after stop** show the measured values at Safety Valve test.

Safety Valve Test Adult/Infant
Wrap an adult cuff around a pipe and connect the cuff to the module. Highlight **Start test** and give the ComWheel a push. The test ends automatically or when **Stop test** (appears in place of **Start test**) is pushed.

Max. press indicates the pressure at which the safety valve opens and is normally 300 ±15 mmHg for adult and 150 mmHg ±15 mmHg for infant. **2 s after stop** indicates the pressure at 2 seconds after the pump has stopped and is normally > 270 mmHg for adult and > 130 mmHg for infant. If the value is less, check leakage by the active leak test.

5.1.5 NIBP pulse valve menu



Start Test **Start test** is for starting and **Stop test** is for stopping the test.

Set Valve **Set Valve** lets you adjust the opening of the pulse valve.

Pulse Valve Data

See NIBP Service menu in chapter 5.1 for information on general items Pressure, Zero, Protect handle, Calibr. prot., +15 V power, AD0 to **AD7** as well as **Timeouts etc.**

Pulse Valve Checking

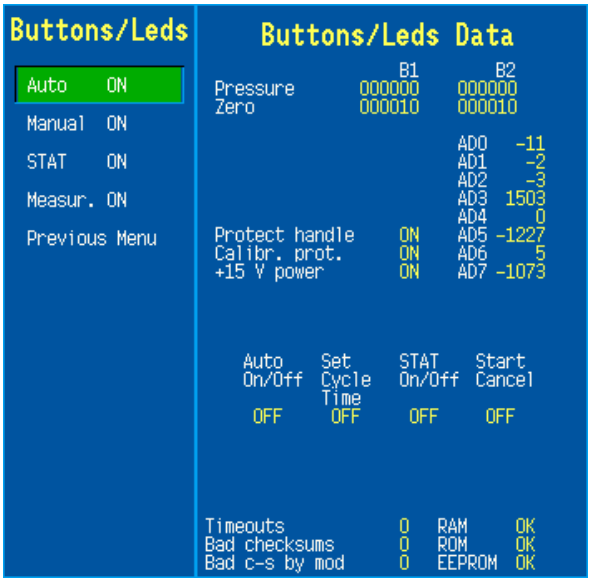
Wrap an adult cuff around a pipe and connect the cuff to the module. Select the **Start test** and push the ComWheel. The pressure rises beyond 240 mmHg and stops. The pulse valve opens. The module counts the time it takes for the pressure to go down from 240 mmHg to 50 mmHg and displays it on the screen. The test can be manually stopped by selecting **Stop test**.

The valve can be adjusted between 0 and 255 (0 for fully closed and 255 for fully open). First select Set Valve and push the ComWheel. See the pulse valve value and adjust it by turning the ComWheel. Then push the ComWheel to confirm the value.

The '**Interval 240 mmHg -> 50 mmHg**' time should be less than 60 seconds when the valve is '150' and less than 10 when fully opened (255). When fully closed (0), the system should be airtight and the pressure does not drop. Depending on an individual, the pulse valve may remain closed up to approx. value 100.

If the measured time deviates much from those above, then the pulse valve or its tubes are faulty.

5.1.6 NIBP buttons/leds menu



The selections ***Auto ON/OFF***, ***Manual ON/OFF***, ***STAT ON/OFF***, and ***Measur. ON/OFF*** have no effect on the module.

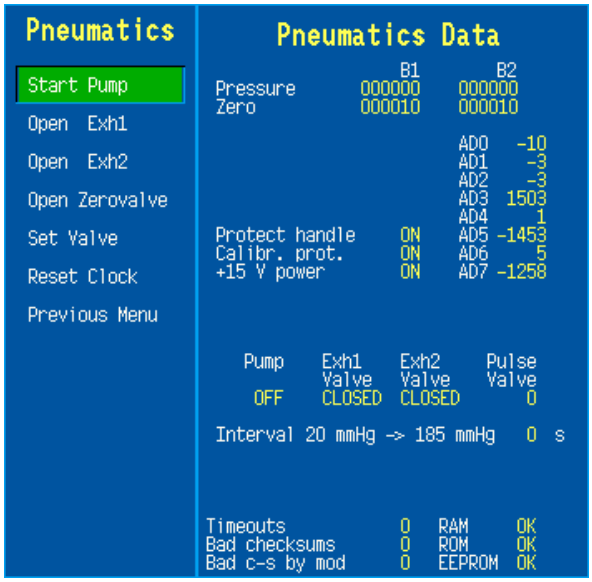
Buttons/Leds Data

See NIBP Service menu in chapter 5.1 for information on general items Pressure, Zero, Protect handle, Calibr. prot., +15 V power, AD0 to AD7 as well as Timeouts etc.

Buttons Checking

The front panel keys function is confirmed by pressing and releasing the key and observing OFF turns to ON at Auto On/Off, and Start Cancel.

5.1.7 NIBP pneumatics menu



Start Pump/Stop Pump
A manual control for the pump. The selection changes to **Stop Pump** when the pump turns on.

Open Exh1/Close Exh1
No effect on the module.

Open Exh2/Close Exh2
A manual control for the exhaust valve 2. The selection changes to **Close Exh2** when the valve is opened.

Open Zero valve
No effect on the module.

Set Valve With **Set Valve**, the opening of the pulse valve is adjusted between 0 and 255 (0 for fully closed and 255 for fully open). First push the ComWheel, then turn it to adjust the value on screen and finally push to set the value.

Reset Clock **Reset Clock** will zero the time on the display.

Pneumatics Data field

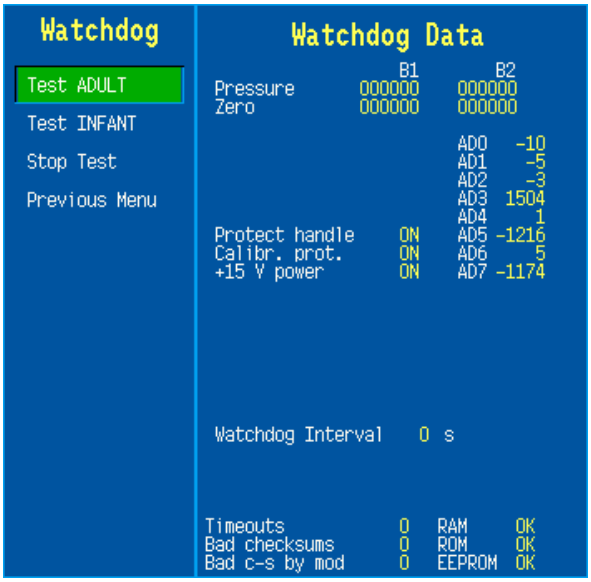
See NIBP service menu in chapter 5.1 for information on general items **Pressure, Zero, Protect handle, Calibr. prot., +15 V power, AD0** to **AD7** as well as **Timeouts** etc.

Pump, Exh1 Valve, and **Exh2 Valve** show their states. Note that **Exh1 Valve** has no effect to the module.

Pulse Valve shows how much the valve is opened (0 to 255) during Valve Setting.

Interval 20 mmHg -> 185 mmHg Checking
Select the **Start pump** at different combinations of the valves open/closed and push the ComWheel. The module counts the time it takes for the pressure to go up from 20 mmHg to 185 mmHg and displays it. When all the valves are closed, the pump should be able to pump the pressure in about 1 to 4 seconds into an adult cuff wrapped around a pipe. The pump does not stop without selecting the **Stop Pump** by pushing the ComWheel.

5.1.8 NIBP watchdog menu



Test ADULT No effect on the module.

Test INFANT No effect on the module.

Stop Test No effect on the module.

Watchdog Data field

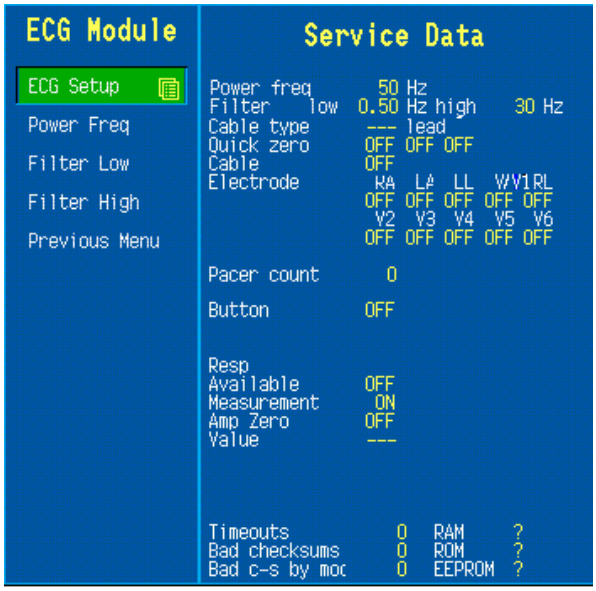
See NIBP Service menu in chapter 5.1 for information on general items **Pressure, Zero, Protect handle, Calibr. prot., +15 V power, AD0** to **AD7** as well as **Timeouts etc.**

Watchdog Interval no effect on the module.

Adult watchdog time testing
No effect on the module.

Infant watchdog time testing
No effect on the module.

5.1.9 ECG service menu



Power freq Set power frequency; 50 Hz/60 Hz.

Filter low Set filter low frequency; 0.05 Hz/0.5 Hz.

Filter high Set filter high frequency; 30 Hz (40 Hz if power freq is 60 Hz) / 100 Hz or 150 Hz @ NE12STPR.

Service Data field

Power freq, and Cable type show the values chosen or detected, **Filter low and high** defines the selected filter (Monitor/Diagnostic/ST).

Quick zero at PRESTN module is ON when the ECG signal is beyond scale, and therefore, is quickly returned to optimal range using fast signal processing methods. All the **Quick zero** bits are ON at the same time.

Cable shows ON when ECG cable is connected.

Electrode shows ON when each of these electrodes are connected.
Pacer count is a running number for pacemaker users.

Button No effect on the module.

Resp Available indicates that ECG hardware is capable of measuring impedance respiration.

Measurement shows ON when the respiration measurement is on.

Amp zero shows ON when zeroing of the respiration amplifier takes place.

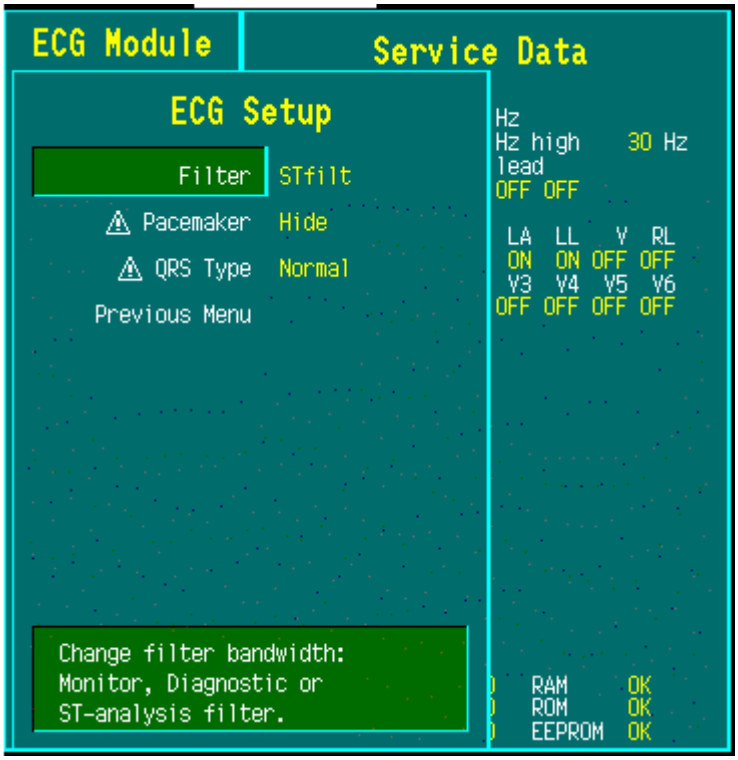
Waveform **VALUE** will be updated in one second interval.

Timeouts is a cumulative number that indicates how many times the module has not responded to the monitor's inquiry. **Bad checksums** is a cumulative number that indicates how many times communication from the module to monitor broke down.
Bad c-s by mod is a cumulative number that indicates how many communication errors the module has detected.

The monitor starts counting these items at power up and resets to zero at power off. The nonzero values do not indicate a failure, but the continuous counting (more than 5 per second) indicates either serial communication failure, or module not in place. Also other modules can cause communication errors that cause these numbers rise.

RAM indicates the state of the RAM memory.
ROM indicates whether the checksum at the EPROM is in accordance with the one the software has calculated.
EEPROM indicates if the values stored in the permanent memory are valid.
The state is either **OK, Fail** or **?** (module not in place or a communication error).

5.1.10 ECG setup menu



Filter Filters the ECG signal high frequency noise and slow respiratory artefacts.

Monit (monitor) filter is used in routine monitoring. It effectively filters the artefacts caused by the electrosurgery unit and respiration.

Diagn (diagnostic) filter is used if more accurate information of the waveform is needed (e.g., of P-wave or AV block). The diagnostic filter is more susceptible to both high frequencies and baseline wander than monitor filter.

STfilt (ST filter) permits more accurate information of ST segment. It filters the high frequency artefacts caused by electrosurgery unit but catches the slow changes in ST segment. The ST filter is more susceptible to baseline wander than the monitor filter.

Pacemaker Selects how to display the pacing pulse of cardiac pacemaker. The selections are **Show, Hide**, **ON R** and **Sensit**.

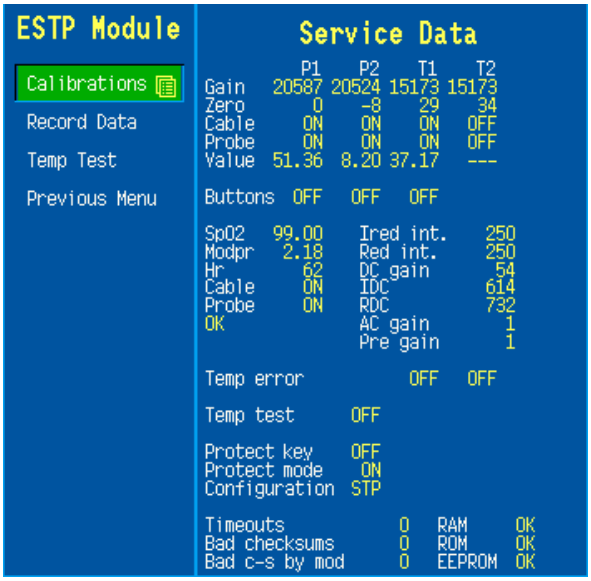
Hide, the pacing pulse is filtered away from ECG data.

Show, the pacer pulse is filtered away from ECG data but the pulse is displayed as a constant height marker.

ON R, pacing pulses are not filtered away from ECG data. This improves ECG monitoring with A-V pacemaker patients, as QRS complexes are counted even if the pacing pulse hits the QRS complex. However, during asystole the monitor may count pacing pulses as heart beats.

Sensit selection uses a more sensitive pacemaker detection. Pacemaker spike is displayed on ECG.

5.2 STP service menu



Record Data Record Data prints out the shown service data and board information (id, serial number and sw id) onto the recorder module, M-REC.

Temp Test **Temp Test** activates the automatic temperature test for the temperature channels T1 and T2. The result from the test is shown in the service data field.

NOTE: The Temp Test needs to be selected twice before the test starts.

Service Data field

Gain is a coefficient to compensate gain error. Usually the values for P1 and P2 are between 17000 and 25000 and for T1 and T2 between 13000 and 14300. **Zero** indicates offset compensation value of each parameter in A/D converter. Typically the values for P1 and P2 are within ±1000 and for T1 and T2 between -150 and +300. Calibrate if zero and/or gain value is outside the ranges.

Cable shows ON when a corresponding cable is connected to the front panel and **Probe** shows ON when a corresponding probe is connected to the cable.

Under **Value** the measured numeric values are displayed simultaneously. Pressure values are real time values and shown in mmHg. Temperature values are shown in degrees Celsius.

The front panel STP keys functions are confirmed by pressing each key and observing OFF turns to ON at **Button**.

SpO_2 shows measured beat-to-beat SpO_2 value. **Modpr** is a modulation % that indicates AC/DC ratio in the measured signal. **Hr** is a pulse rate calculated from every beat.

Cable and **Probe** can be either OFF or ON, and these indicate the state PROBE OFF.
Under them there is a message field for SpO_2. It can be OK, PULSE SEARCH, NO PROBE, PROBE OFF, NO PULSE, ARTEFACT, POOR SIGNAL, or CHECK PROBE.

Balance between leds is adjusted by changing the intensity of red/infrared. Intensity of infrared (**Ired int.**) is in the range of 40 to 255 and red intensity (**red int.**)is in the range of 40 to 255.

DC gain shows the gain of DC signal adjusted by the module.

IDC is the value of infrared signal.

RDC is the dc value of red signal.

AC gain is the gain of infrared and red ac signals. AC gain values can be 1 or 0. Value 1 means high ac gain and 0 means low gain.

Pre gain is a preamplifier gain for infrared and red signals. Pre gain values can be 1 or 0. Value 1 means normal operation. Value 0 means that signal levels are very low and extra gain is taken into use.

Temp error shows the status of the temperature test. No errors found show the status (OFF) and errors found (ON).

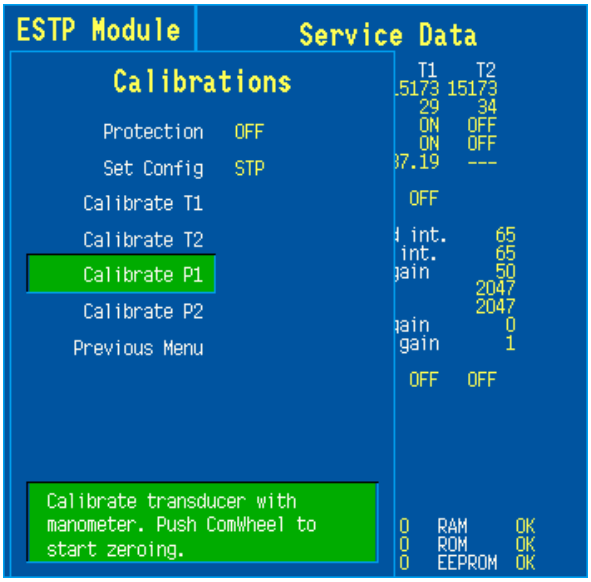
Protect key shows normally OFF but turns to ON when the button at the bottom of the module is pressed.

Protect mode is normally ON. It turns to OFF when Protect is switched to OFF for the temperature calibration in Calibration Menu.
Configuration shows the chosen module configuration: TP, ST, or STP.

Timeouts is a cumulative number that indicates how many times the module has not responded to the monitor's inquiry. **Bad checksums** is a cumulative number that indicates how many times communication from the module to monitor broke down.
Bad c-s by mod is a cumulative number that indicates how many communication errors the module has detected.
The monitor starts counting these items at power up and resets to zero at power off. The nonzero values do not indicate a failure, but the continuous counting (more than 5 per second) indicates either serial communication failure, or module not in place. Also other modules can cause communication errors that cause these numbers rise.

RAM indicates the state of the RAM memory.
ROM indicates whether the checksum at the EPROM is in accordance with the one the software has calculated.
EEPROM indicates if the values stored in the permanent memory are valid.
The state is either **OK, Fail** or **?** (module not in place or a communication error).

5.2.2 STP calibration menu



Protection Protection for the configuration and temperature calibrations can be set ON and OFF .

Set Config The module configuration should be set according to the module type. The setting is possible only when the protection is set OFF. The available selections are TP, ST or STP. The configuration setting should be checked if the STP board is replaced.

Calibrate T1 / Calibrate T2

The functions are for calibrating the temperature channels T1 and T2. The calibrations are possible only when the protection is set OFF. The temperature calibration requires accurate test plugs of value 25 °C and 45 °C.

Calibration:

1. Select ***Calibrate T1/Calibrate T2***
2. Insert the test plug 25 °C into the T1/T2 connector
3. Press the ComWheel
4. Insert the test plug 45 °C into the T1/T2 connector
5. Press the ComWheel

Calibrate P1/Calibrate P2

The functions are for calibrating the invasive blood pressure channels P1 and P2. The calibrations require a pressure transducer (with an appropriate cable) and a pressure manometer.

1. Connect the pressure transducer with the pressure manometer to the P1/P2 connector. Select ***Calibrate P1/Calibrate P2***. Leave the transducer to room air pressure.
2. Press the ComWheel to start zeroing.
3. Supply a pressure of 100 mmHg to 300 mmHg to the transducer. The recommended pressure is 200 mmHg.
4. Set the pressure on the display to match the pressure reading on the manometer and press the ComWheel.

6 SPARE PARTS

6.1 Spare parts list

6.1.1 M-PRESTN rev. 01, M-RESTN rev. 01, M-PRETN rev. 01

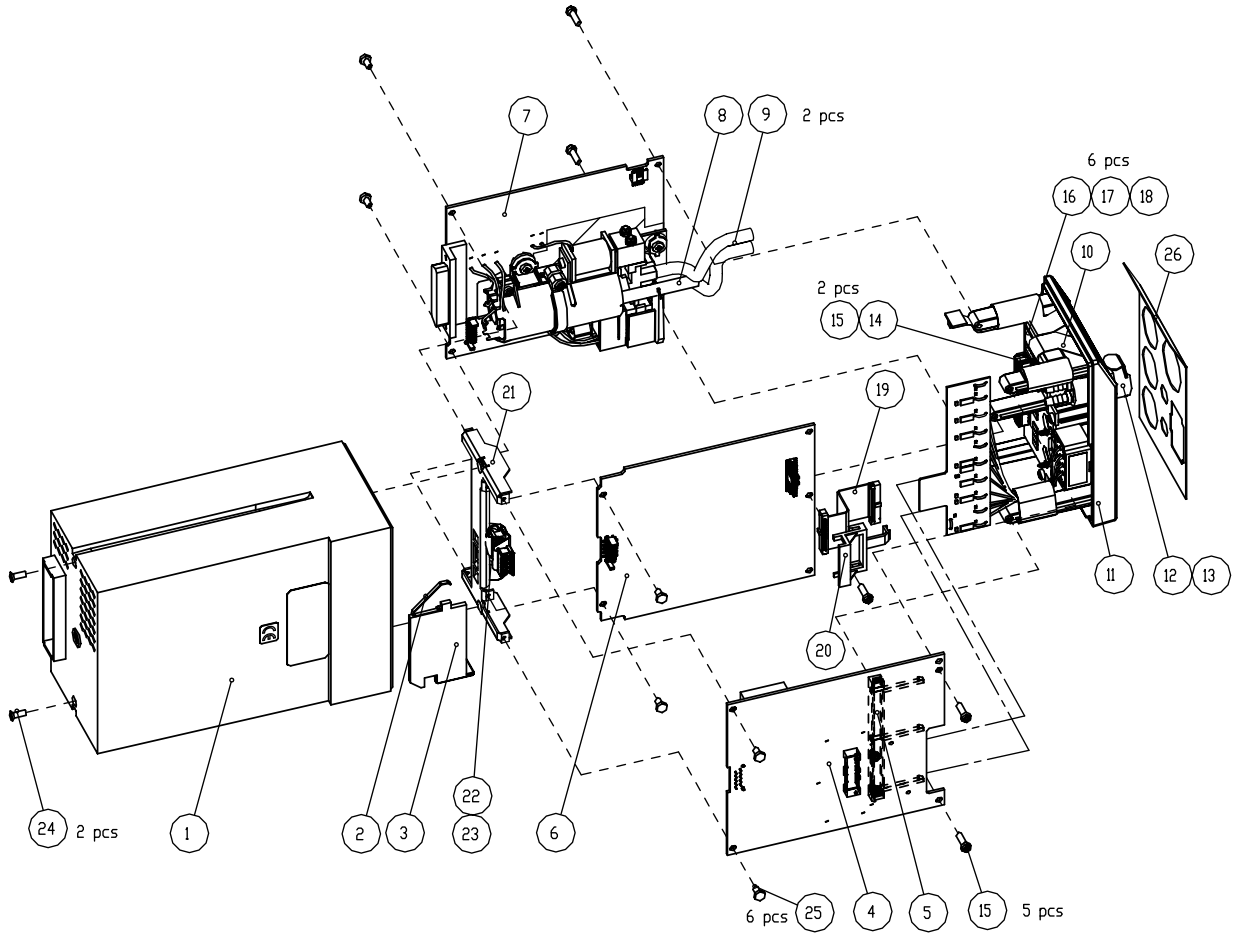


Figure 20 Exploded view of M-PRESTN Module

Item	Description	Order No.	Replaced by
1	Module box (wide)	886168	
2	Spring pin	879182	
3	Latch for module box	879181	
4	ECG_120 board	M1008909	
5	ECG Input board holder	M1021216	
6	STP_120 board	M1006153	
7	NIBP unit	M1012677	
8	Air filter (NIBP)	57142	
9	Silicon tube NIBP (2pcs, 100mm)	73375	
10	Membrane keypad	8005215	
11	Mask including NIBP flex board and ECG connector unit	M1018978	
12	NIBP Cuff connector	64654	

Item	Description	Order No.	Replaced by
13	NIBP Mounting nut	8004036	
14	TEMPERATURE input board	8005216	
15	Screw; pan-head, TORX PT 3x10mm (7 pcs)	628728	
16	PRESS / SpO2 input board, M-PRESTN	8005219	
16	PRESS input board, M-PRETN	8005492	
16	SpO2 input board, M-RESTN	8005490	
17	Screw; Cross head recess PT 2.5x10 (6kpl)	M1021234	
18	Fitting plate (only M-RESTN, M-PRETN)	879510	
19	STP cable (34 contacts, female)	M1001763	
20	Cable holder	M1008749	
21	Board holder	M1021283	
22	Module bus cable	8004009	
23	Cable tie	64001	
24	Screw; cross head recess M3x8 black (2 pcs)	616215	
25	Screw; cross head cylinder M3x6 (6 pcs)	61721	
26	Front panel, DA, M-PRESTN	M1021293	
26	Front panel, DE, M-PRESTN	M1021294	
26	Front panel, EN, M-PRESTN	M1021440	
26	Front panel, ES, M-PRESTN	M1021295	
26	Front panel, FI, M-PRESTN	M1021296	
26	Front panel, FR, M-PRESTN	M1021297	
26	Front panel, IT, M-PRESTN	M1021298	
26	Front panel, JA, M-PRESTN	M1021299	
26	Front panel, NL, M-PRESTN	M1021300	
26	Front panel, NO, M-PRESTN	M1021301	
26	Front panel, PL, M-PRESTN	M1021302	
26	Front panel, PT, M-PRESTN	M1021303	
26	Front panel, SV, M-PRESTN	M1021305	
26	Front panel, DA, M-PRETN	M1021423	
26	Front panel, DE, M-PRETN	M1021424	
26	Front panel, EN, M-PRETN	M1021422	
26	Front panel, ES, M-PRETN	M1021425	
26	Front panel, FI, M-PRETN	M1021426	
26	Front panel, FR, M-PRETN	M1021427	
26	Front panel, IT, M-PRETN	M1021428	
26	Front panel, JA, M-PRETN	M1021429	
26	Front panel, NL, M-PRETN	M1021430	
26	Front panel, NO, M-PRETN	M1021431	
26	Front panel, PL, M-PRETN	M1021432	
26	Front panel, PT, M-PRETN	M1021433	
26	Front panel, SV, M-PRETN	M1021434	
26	Front panel, DA, M-RESTN	M1021441	
26	Front panel, DE, M-RESTN	M1021443	
26	Front panel, EN, M-RESTN	M1021440	
26	Front panel, ES, M-RESTN	M1021444	
26	Front panel, FI, M-RESTN	M1021445	
26	Front panel, FR, M-RESTN	M1021446	
26	Front panel, IT, M-RESTN	M1021447	
26	Front panel, JA, M-RESTN	M1021448	
26	Front panel, NL, M-RESTN	M1021449	
26	Front panel, NO, M-RESTN	M1041450	

Item	Description	Order No.	Replaced by
26	Front panel, PL, M-RESTN	M1021451	
26	Front panel, PT, M-RESTN	M1021452	
26	Front panel, SV, M-RESTN	M1021453	

7 EARLIER REVISIONS

No earlier revisions.

For your notes:

APPENDIX A

SERVICE CHECK FORM

DATEX-OHMEDA M-PRESTN, M-RESTN, M-PRETN MODULES

Customer					
Service		Module type		S/N	
Service engineer				Date	

☐ OK = Test OK ☐ N.A. = Test not applicable ☐ Fail = Test Failed

All modules	OK	N.A.	Fail		OK	N.A.	Fail
1. Internal parts	☐	☐	☐	2. External parts	☐	☐	☐
3. NIBP pump filter	☐	☐	☐	4. Installation	☐	☐	☐
5. Recognition	☐	☐	☐				

Notes _____

ECG measurement S/N

6. Module software (serial numbers)

ECG/RESP	
STP	
NIBP	

	OK	N.A.	Fail		OK	N.A.	Fail
7. Communication and memories	☐	☐	☐	8. Power frequency	☐	☐	☐
9. Cable recognition	☐	☐	☐	10. Lead detection	☐	☐	☐
11. Test with patient simulator	☐	☐	☐				

Notes _____

RESP measurement S/N

	OK	N.A.	Fail		OK	N.A.	Fail
12. RESP measurement recognition	☐	☐	☐	13. Test with patient simulator	☐	☐	☐

Notes

TEMP measurement S/N

	OK	N.A.	Fail		OK	N.A.	Fail
14. Communication and memories	☐	☐	☐	15. Temperature probe detection	☐	☐	☐
16. Calibration check	☐	☐	☐	17. Temp test -function	☐	☐	☐
18. Configuration STP/ST/TP	☐	☐	☐				

Notes

InvBP measurement S/N

	OK	N.A.	Fail		OK	N.A.	Fail
19. Membrane keys	☐	☐	☐	20. Cable and transducer detection	☐	☐	☐
21. Calibration	☐	☐	☐	22. Test with patient simulator	☐	☐	☐

Notes

SpO_2 measurement S/N

	OK	N.A.	Fail		OK	N.A.	Fail
23. SpO_2 probe detection	☐	☐	☐	24. Test measurement	☐	☐	☐

Notes

NIBP measurement S/N

	OK	N.A.	Fail		OK	N.A.	Fail
25. Communication and memories	☐	☐	☐	26. Membrane keys	☐	☐	☐
27. Pump and valves	☐	☐	☐				

28. Leak test		28. ≤ 6 mmHg/min

29. Calibration check	Measured B1	Measured B2	Allowed range
0 mmHg			± 9 mmHg
100 mmHg			100 ± 2 mmHg
200 mmHg			200 ± 3 mmHg
260 mmHg			260 ± 4 mmHg

30. Safety valve functions

	B1	B2	Allowed range
'Max press' ADULT			270 to 330 mmHg
'2 s after stop' ADULT			270 to 330 mmHg
'Max press' INFANT			130 to 165 mmHg
'2 s after stop' INFANT			130 to 165 mmHg

	OK	N.A.	Fail		OK	N.A.	Fail
31. Cuff related messages	☐	☐	☐	32. Adult cuff detection	☐	☐	☐
33. Test measurement	☐	☐	☐	34. Infant cuff detection	☐	☐	☐

Notes _____

All modules

	OK	N.A.	Fail		OK	N.A.	Fail
35. Electrical safety check	☐	☐	☐	36. Functioning after electrical safety check	☐	☐	☐
37. Final cleaning	☐	☐	☐				

Notes _____

Notes _____

Used Spare Parts _____ _____ _____

_____ _____ _____

_____ _____ _____

_____ _____ _____

Signature _____