Datex-Ohmeda Hemodynamic modules
S/5™ NE12STPR Module, M-NE12STPR (rev. 01)
S/5™ NE12STR Module, M-NE12STR (rev. 01)
S/5™ NE12TPR Module, M-NE12TPR (rev. 01)
S/5™ NESTPR Module, M-NESTPR (rev. 01)
S/5™ NESTR Module, M-NESTR (rev. 01)
S/5™ NETPR Module, M-NETPR (rev. 01)
S/5™ ESTPR Module, M-ESTPR (rev. 04)
S/5™ ESTR Module, M-ESTR (rev. 04)
S/5™ ETPR Module, M-ETPR (rev. 04)

Technical Reference Manual Slot

All specifications are subject to change without notice.

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INTRODUCTION

This Technical Reference Manual Slot provides information for the maintenance and service of the hemodynamic modules. Please see also related *Technical Reference Manual* for information related to system e.g. related documentation, conventions used, symbols on equipment, safety precautions, system description, system installation, interfacing, functional check and planned maintenance.

The S/5 M-ESTPR/-ESTR/-ETPR and S/5 M-NE12STPR/-NE12STR/-NE12TPR/-NESTPR/-NESTR/-NETPR are double width modules designed for use with S/5 monitors. The modules provide general hemodynamic parameters. Later in this manual modules can be called w/o system name S/5.

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-MRI/-MRIP

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

Figure 1 S/5 NE12STPR Module, M-NE12STPR

Table 1 Options of S/5 hemodynamic modules

	Parameter	NE12STPR	NESTPR	NE(12) STR	NE(12) TPR	ESTPR	ESTR	ETPR
12	12-lead ECG	•		(•)	(•)			
N	NIBP	•	•	•	•			
E	ECG	•	•	•	•	•	•	•
S	Pulse oximetry	•	•	•		•	•	
T	Two temperatures	•	•	•	•	•	•	•
P	Two invasive blood pressures	•	•		•	•		•
R	Impedance respiration	•	•	•	•	•	•	•

1 SPECIFICATIONS

1.1 General specifications

Module size	75 × 180 × 112 mm
W × D × H	3.0 × 7.1 × 4.4 in
Operation temperature	10...40 °C / 50...104 °F

@ M-ESTPR/-ETPR/-ESTR

Module weight	0.6 kg / 1.3 lbs
Power consumption	6 W

@ M-NE12STPR/-NE12STR/-NE12TPR/-NESTPR/-NESTR/-NETPR

Module weight	1 kg
Power consumption	about 9 W

1.2 Typical performance

1.2.1 NIBP

Oscillometric measurement principle.

Measurement range	adult	25...260 mmHg
	child	25...195 mmHg
	infant	15...145 mmHg
Pulse rate range accepted	30...250 bpm	
Measurement interval	from continuous to 1h, 2h, 4h	
Typical measuring time	adult	23 s
	infant	20 s
Initial inflation pressure	adult	185 ±10 mmHg
	child	150 ±10 mmHg
	infant	120 ±10 mmHg
Venous stasis	adult	80 ±10 mmHg / 2 min.
	child	60 ±10 mmHg / 2 min.
	infant	40 ±10 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...150 Hz
Diagnostic @ other modules	0.05...100 Hz
Monitoring	0.5...30 Hz (-3 dB, with 50 Hz reject filter) 0.5...40 Hz (-3 dB, with 60 Hz reject filter)
ST filter	0.05...30 Hz (-3 dB, with 50 Hz reject filter) 0.05...40 Hz (-3 dB, with 60 Hz reject filter)

HEART RATE FROM ECG

Range	30...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...+9 mm (-0.9...+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...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	40...100 %
Accuracy	100...80 %, ±2 digits
(% SpO_2 ±1 SD)[1]	80...50 %, ±3 digits
	50...40 %, 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 over the measurement range against functional saturation SpO_2 func.

HEART RATE FROM PLETH

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

[1] 1 SD (standard deviation) = 68 % of all readings in the specified range in stable conditions.

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...45 °C (50...113 °F)

(In rev. ESTP 03/ EST 02/ETP 02 or earlier: 15...45 °C (59...113 °F))

Measurement accuracy	±0.1 °C (25...45.0 °C) ±0.2 °C (10...24.9 °C)
Display resolution	0.1 °C (0.1 °F)
Temperature test	automatic (every 10 min)
Probe type	compatible with YSI 400 series

1.2.5 Invasive blood pressure

Measurement range	-40...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...320 mmHg
Resolution	±1 mmHg

WAVEFORM DISPLAY

Range	-30...300 mmHg

HEART RATE FROM ARTERIAL PRESSURE

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

1.2.6 Respiration

Measurement range	4...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.	5...13 mmHg/s
Inflation time	20...185 mmHg, 1...5 s

Automatic software control, max. inflation pressure

adult	280 ±10 mmHg
child	200 ±10 mmHg
infant	150 ±10 mmHg

Over pressure limit, stops measurement after 2 seconds

adult	320 mmHg
child	220 mmHg
infant	165 mmHg

Safety valve limits the maximum cuff pressure to 320 mmHg in adult/child mode or 165 mmHg in infant mode. Independent timing circuit limits pressurizing (>5 mmHg) time to 2 minutes 10 seconds maximum in adult/child mode, and 1 minute 5 seconds 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	2 min
	child	2 min
	infant	1 min

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	2 s
Input impedance	>2.5 MΩ (10 Hz)
CMRR	>100 dB (ST)
System noise	<40 µV (p-p, RTI)
Allowable offset	±300 mVDC
Gain range	0.2...5.0 cm/mV
Pacemaker pulse detection	2...500 mV, 0.5...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...45.0 °C) ±0.2 °C (10.0...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 check 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...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 check the transducer/probe specification.

1.3.6 Respiration

Excitation frequency @ 12-lead ECG	62.5 kHz
Excitation frequency @ other modules	31.25 kHz
Breath detection	automatic, range 0.3...6 Ω manually adjustable minimum detection: 0.2, 0.4, 0.6, 0.8, 1.0
Input dynamic range	0.2...6 Ω
Input impedance range	100...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-NE12STPR/-NE12STR/-NE12TPR/-NESTPR/-NESTR/-NETPR (or M-NIBP) module
- twin hose (adult or infant model)
- blood pressure cuffs (different 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 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 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 to LEDs in the probe. Pulse oximeter derives the oxygen saturation ($SpO_{2)}$ using 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 the above pulse oximetry principle is that due to only two wavelengths used 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**

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

The oxygen saturation percentage SpO_2 measured by Datex-Ohmeda module is calibrated against the 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 oximeter is 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.

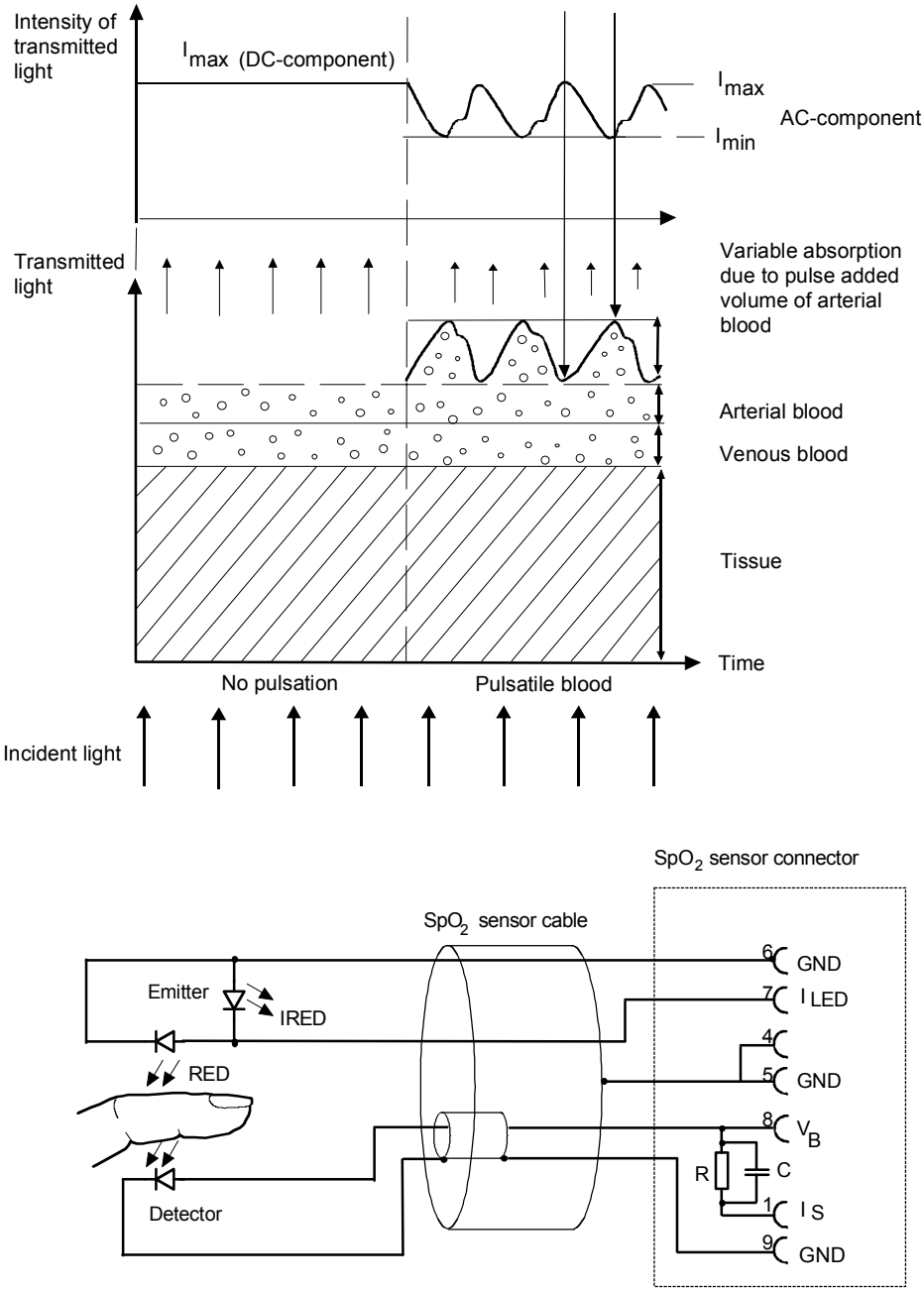


Figure 2 **Absorption of infrared light in the finger probe parts layout and schematic diagram**

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 a 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 signal of the respiration is made by supplying current between 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 respiration waveform is displayed on the screen.

2.2 Main components

2.2.1 M-ESTPR/-ETPR/-ESTR modules

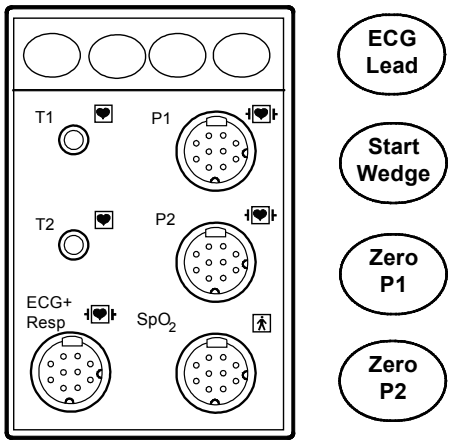


Figure 3 Front panel of M-ESTPR

The **M-ESTPR, M-ETPR, and M-ESTR modules** contain two main PC boards, the STP board and the ECG board. They work independently. Both of them have their own processor and software EPROM. Some components on the boards are not used in ETPR and ESTR modules.

In **M-ESTPR module**, additionally, there are two small boards, the SP input and the ECG input

boards, attached to the front panel of the module. The front panel has six connectors and four keys. The connectors are two for temperature measurement, two for invasive blood pressure measurement, one for ECG, and one for SpO_2 measurement. The keys are for ECG lead, Start Wedge, P1 zero, and P2 zero.

In **M-ETPR module**, there are two small boards, the ECG input board and the 2P input board attached to the front panel of the module. The front panel has five connectors and four keys. The connectors are two for temperature measurement, two for invasive blood pressure measurement, and one for ECG measurement. The keys are for ECG lead, Start Wedge, P1 zero, and P2 zero.

In **M-ESTR module**, there are two small boards: the S input board and the ECG input board, attached to the front panel of the module. The front panel has four connectors and one key. The connectors are two for temperature measurement, one for ECG, and one for SpO_2 measurement. The key is for ECG lead select.

NOTE: M-ESTP rev. 03, M-ETP rev. 02 and M-EST rev. 02 and all earlier revisions have separate T and SP input boards.

2.2.2 M-NE12STPR/-NE12STR/-NE12TPR/-NESTPR/-NESTR/-NETPR modules

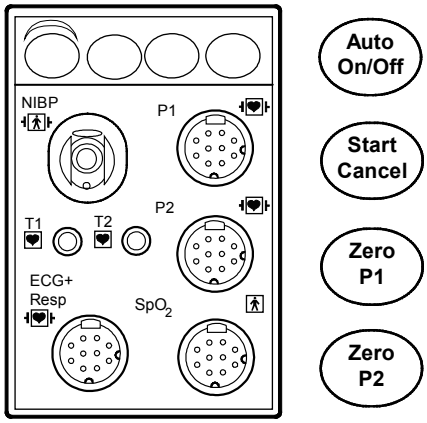


Figure 4 Front panel of M-NESTPR

The **M-NESTPR, M-NETPR, and M-NESTR 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 EPROM.

The **M-NE12STPR, M-NE12TPR, and M-NE12STR** contain three main PC boards, The STP board, the ECG board and the NIBP board. They work independently. Each of them has their own processor. The STP board and NIBP board have software EPROM. In the ECG board the software is in flash memory. The STP and NIBP boards are the same as in M-NESTPR module but the ECG board and ECG input board are different.

In **M-NESTPR module**, 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. The structure of **M-NE12STPR** is similar except the ECG board and ECG input board are different.

In **M-NETPR module**, there are two small boards, the 2P input board and the ECG input board, attached to the front panel of the module. The front panel has six connectors and four keys. The connectors are two for temperature measurement, two for invasive blood pressure measurement, one for ECG, and one for NIBP. The keys are for Auto On/Off, Start/Cancel, P1 zero, and P2 zero. The structure of **M-NE12TPR** is similar except the ECG board and ECG input board are different.

In **M-NESTR module**, there are two small boards, the ECG input board and the S input board, attached to the front panel of the module. The front panel has five connectors and two keys. The connectors are two for temperature measurement, and one for SpO_2 measurement, one for ECG, and one for NIBP. The keys are for Auto On/Off, Start/Cancel. The structure of **M-NE12STR** is similar except the ECG board and ECG input board are different.

2.2.3 NIBP board

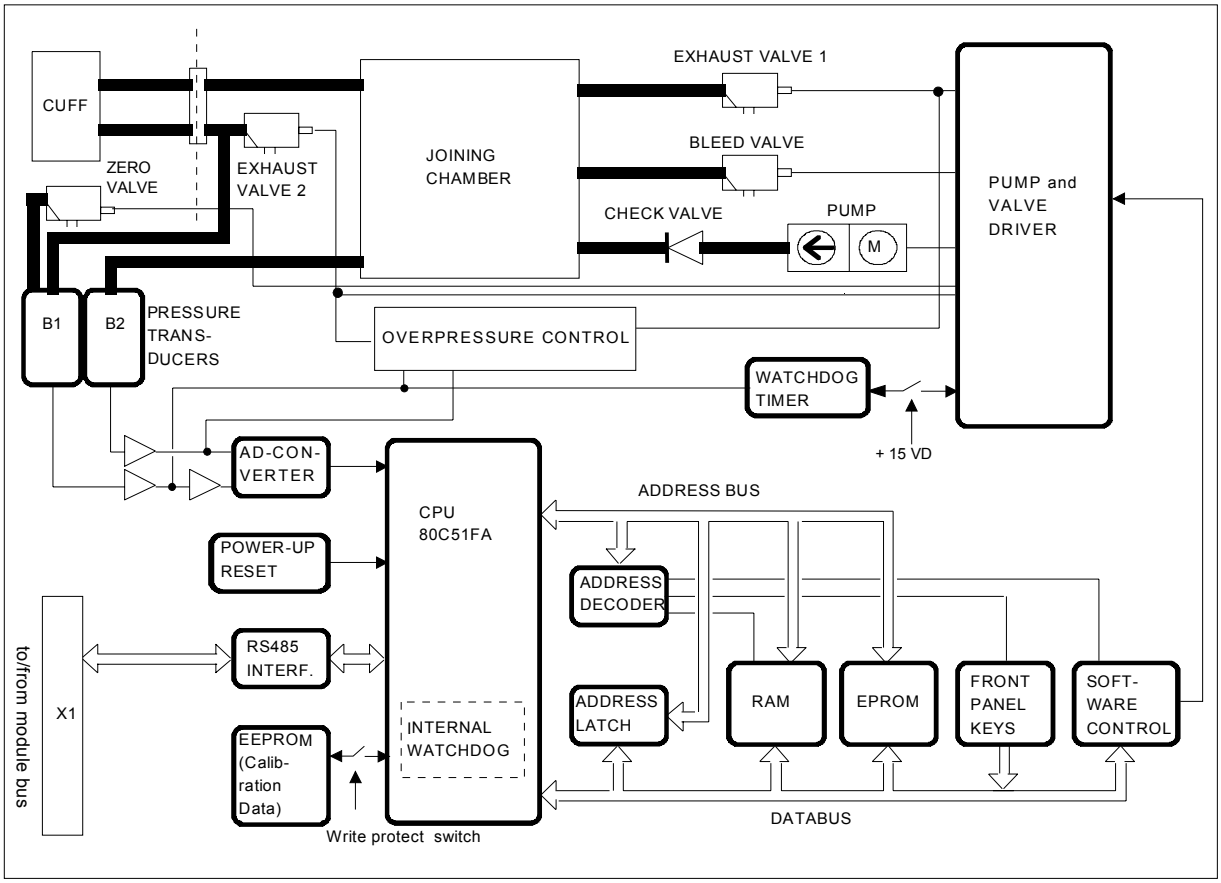


Figure 5 NIBP board functional block diagram

Pressure transducers

The NIBP board contains two pressure transducers. They are of piezoresistive type. One is used for measuring the pressure of the blood pressure cuff and the pressure fluctuations caused by arterial wall movement (B1). The other is used for detection of cuff hose type, cuff loose and cuff occlusion situations etc. (B2). The transducers are internally temperature compensated. They are supplied by a constant voltage and their output voltage changes up to 40 mV max. (50 kPa, 375 mmHg).

Signal processing

Two signals from the pressure transducers are amplified and sent to A/D converter. After the converter, digitized signals are sent to microprocessor for data processing. Before the converter, one of the signals is used to adjust the offset to the pressure safety level.

The NIBP board is controlled with 80C51FA microprocessor at 16 MHz oscillator frequency.

Memory

NIBP program memory (EPROM) size is 128k × 8. RAM size is 32k × 8 bit and it stores variable values in NIBP measurement. EEPROM is size 64 × 16 bit and 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 ECG board's description: *"RS485 communication"*

Watchdog timer

The NIBP board is equipped with software independent safety circuit to disconnect supply voltages from the pump and the valves if the cuff has been pressurized longer than preset time. As soon as the cuff pressure rises over a specifiedpressure limit, timer starts counting. The timer is adjusted to stop the pump and open the valves in 2 minutes 10 seconds in adult/child mode and in 1 minute 5 seconds in infant mode.

Valves

Exhaust valves are used for emptying the cuff and the joining chamber after the measurement. Exhaust valve 1 is also used as safety valve in infant mode. Valve opens at 165 mmHg. Exhaust valve 2 is also used as safety valve in adult mode and opens at 320 mmHg.
Bleed valve is used for emptying the cuff during measurement. Zero valve is used for connecting the pressure transducer B1 to open air.

Power supply section

All connections are established via 25-pin connector (D-type, female). The module needs +5 V, ±15 V, and +15 VD (dirty) power supply to operate. The pump and the valves use separate +15 VD power line. The supply voltages are generated in the power supply section of the S/5 monitor. The reference voltages ±5 V_{ref} and +10 V_{ref} are generated on the NIBP board.

2.2.4 ECG board in 3-and 5-lead measurement

Patient signals are connected to overload protection circuits (resistors and gas-filled surge arresters) and analog switches to instrumentation amplifiers. Then the signals are amplified by 480 and limited by slew rate. Then they are A/D-converted, analyzed and transferred to module bus in digital form.

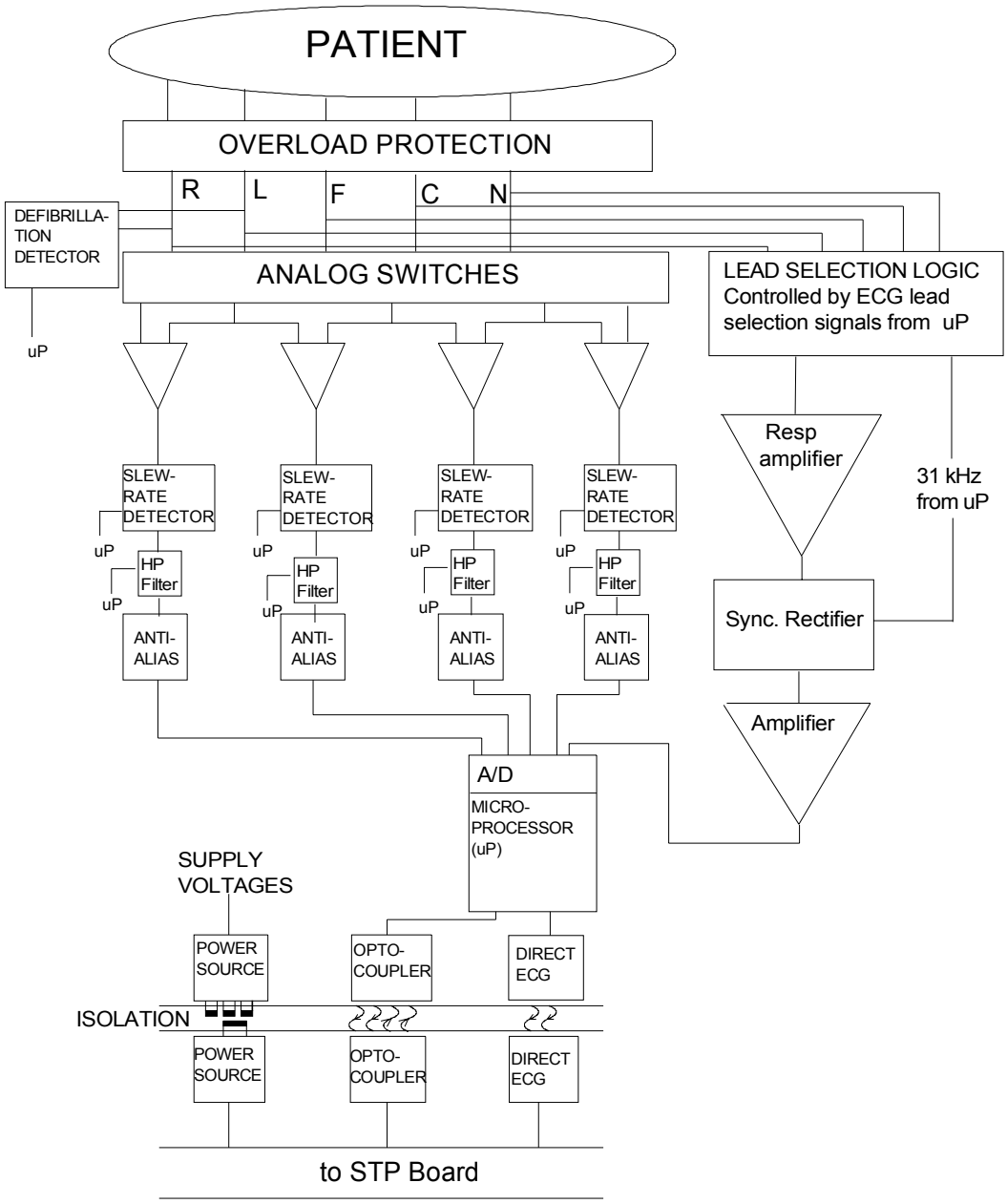


Figure 6 3- and 5- lead ECG board block diagram

Analog ECG section

ECG cable is connected to connector pins E1 to E6 on the input board which contains an overload protection circuit. Leads are connected to amplifiers via analog switches. States of the switches depend on the cable type. Lead-off, noise and pacemaker are detected by a slew rate detector.

Lower frequency is determined by high pass (HP) filter 0.5 Hz (monitor bandwidth) or 0.05 Hz (diagnostic or ST- bandwidth).

Respiration section

3-lead cable

The analog switches control the current supply source of the impedance respiration measurement, and the lead selection for the 3-lead cable can be seen from the following table:

Table 2 Lead selection and coding for the 3-lead cable

Selected lead	Current source between	Signal measured from
I	R - L	N
II	R - N	L
III	L - N	R

Position on body surface	IEC standard coding	AAMI standard coding
right arm	R = red	RA = white
left arm	L = yellow	LA = black
left leg	F = green	LL = red

5-lead cable

When the 5-lead cable is used, the current source is between L-F and the signal is measured from the N, independently on the lead selection.

The respiration amplifier consist of the operational amplifiers, and the components around them. There is an analog switch for controlling the gain of the first stage of the preamplifier. Synchronous rectifier consists of the analog switches, which are used for detecting the respiration signal from 31 kHz amplitude modulated raw signal. The amplifier stage consists of the differential amplifier and the last amplifier. The differential amplifier consists of the operational amplifiers and the components around them. This stage is AC-coupled on both sides for minimising the offset voltages. The last amplifier is used for amplifying the signal derived from differential amplifier stage. The respiration signal is zeroed at the beginning of the measurement. Zeroing is also used for fast recovering the measurement after the motion artefact. This is done in amplifier section.

NOTE: The respiration measurement is switched OFF for 20 seconds when defibrillation is detected at the defibrillation detector.

Microprocessor section

Microprocessor contains RAM and EPROM memories. The processor uses external EEPROM memory. The microprocessor's internal 8-channel A/D-converter converts the ECG-signals to digital form. See the section in ECG board's description: *"RS485 communication*

Serial communication

Communication with the module bus is made through RXD and TXD pins. See the section in STP board's description: *"Serial communication".*

Isolated section

The patient isolation of ECG is 5 kV.

NOTE: The isolation has been changed from the earlier revisions.

WARNING **Do not touch battery operated monitor during defibrillation procedure.**

See the *"Isolated section"* in STP board description.

Power supply section

See the *"Power supply section"* in STP board description.
There is a test connector (X20) on the board for voltages +5 VREF, +5 V, +12 V, GND and -12 V.

2.2.5 ECG board in 12-lead measurement

The 12-lead ECG measurement consists of the functions, which are shown in the figure 7. All functions are located in the ECG board except the front panel connector and the ECG input board.

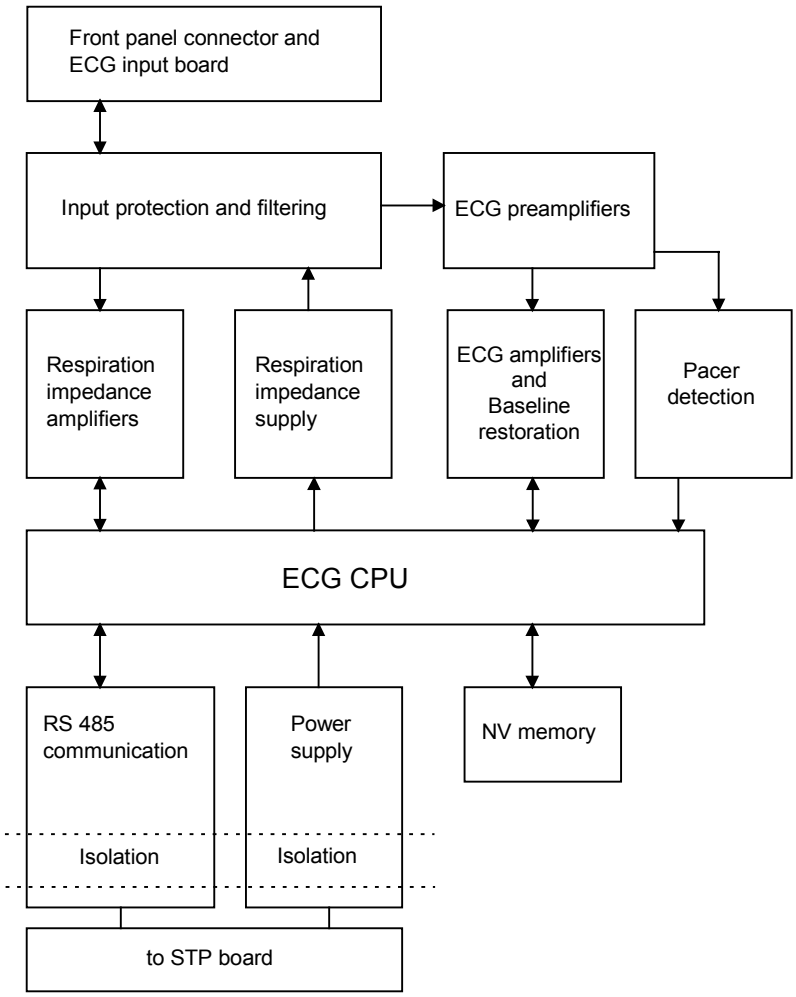


Figure 7 **12-lead ECG measurement block diagram**

Front panel connector and ECG input board

The connector for the 12-lead ECG cable is a green 12 pin Nicolay type connector. 3- or 5-lead cables with blue connector cannot be connected to this connector. The ECG input board contains high voltage resistors and a connector for ECG board.

Input protection and filtering

The input protection is implemented with protection diodes, which are connected to analog power supply voltage and ground. The input filtering for ECG measurement is done with discrete components. The measured signal is AC-coupled for respiration measurement. The signal from the respiration supply is AC coupled. There are also the overload protection diodes for respiration measurement supply.

ECG preamplifiers

The buffer amplifiers are used for each lead except N/RL. The leads off detection is implemented by measuring the 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 two 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 62.5 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. Respiration is always measured between R and F, independently on the ECG lead selection.

ECG CPU

The CPU is a 16 bit H8/3048 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.

2.2.6 ECG filtering

The S/5 monitors have three ECG filtering modes:

MONITORING	0.5...30 Hz (with 50 Hz reject filter) 0.5...40 Hz (with 60 Hz reject filter)
DIAGNOSTIC @ 12-lead ECG	0.05...150 Hz
DIAGNOSTIC @ other modules	0.05...100 Hz
ST FILTER	0.05...30 Hz (with 50 Hz reject filter) 0.05...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 hardware. 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 and they are done with software. They are for the mains supply filtering. When these filters are used, 3 dB value for low-pass filter is 30 Hz or 40 Hz.

In diagnostic mode the upper frequency is limited by hardware and the -3 dB frequency is 100 Hz for 3 or 5 lead ECG measurement. For 12 lead ECG the upper frequency is 150 Hz and it is limited by software.

2.2.7 STP board

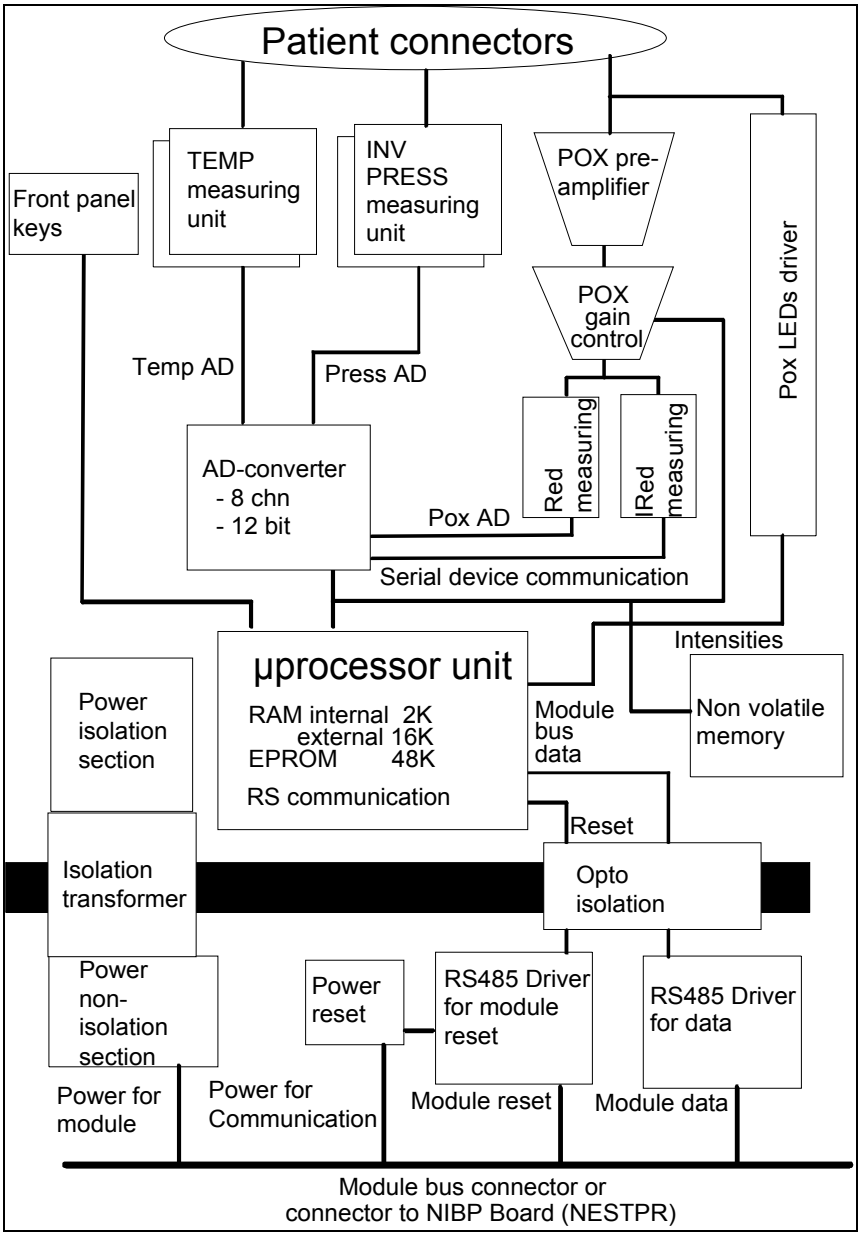


Figure 8 STP board block diagram

Microprocessor unit

As processor, Intel's 80C196KC-16 is used. There are external memories, an 8-bit data bus, a 16 MHz oscillator, an open collector reset, and a watchdog timer. Three A/D-converters within the processor are used. The processor's internal UART communicates with the CPU board.

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

Temperature measurement unit

Value of NTC-resistor in the probe depends on patient's temperature. It is measured with the following principle.

The temperature signal(s) is produced by voltage dividers, part of which is the patient probe (YSI 400-series thermistor). The output is amplified by the calibrated amplifier(s) whose offset voltage makes its output spread on both sides of zero. Wider output range (measurement range) means better resolution.

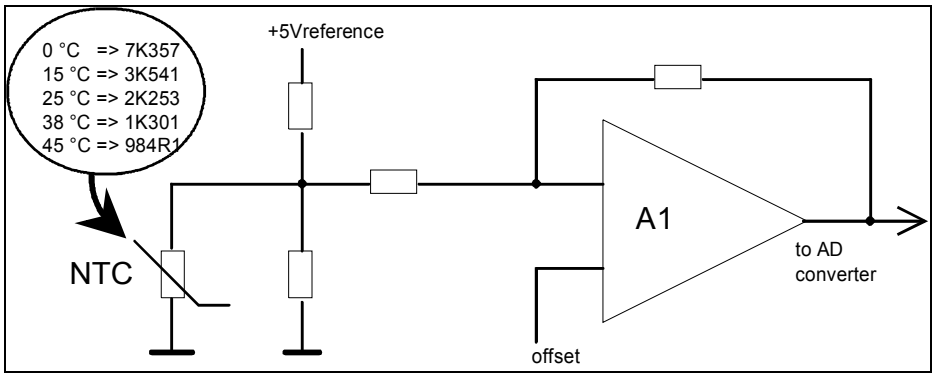


Figure 9 Temperature measurement principle

Invasive blood pressure measurement unit

Isolated +5 V voltage is supplied to the pressure transducer. From the bridge connection a differential voltage, which depends on pressure and supplied voltage, is calculated (see the formula below).

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

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

Pressure amplification is realized in the instrumentation amplifier. Gain of the amplifier is set so that the level of the signal transferred to A/D converter stays 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.

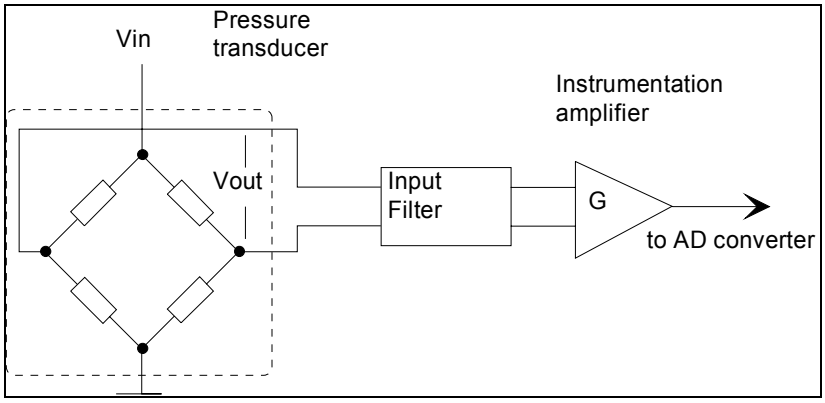


Figure 10 Pressure measurement principle

Pulse oximetry measurement section

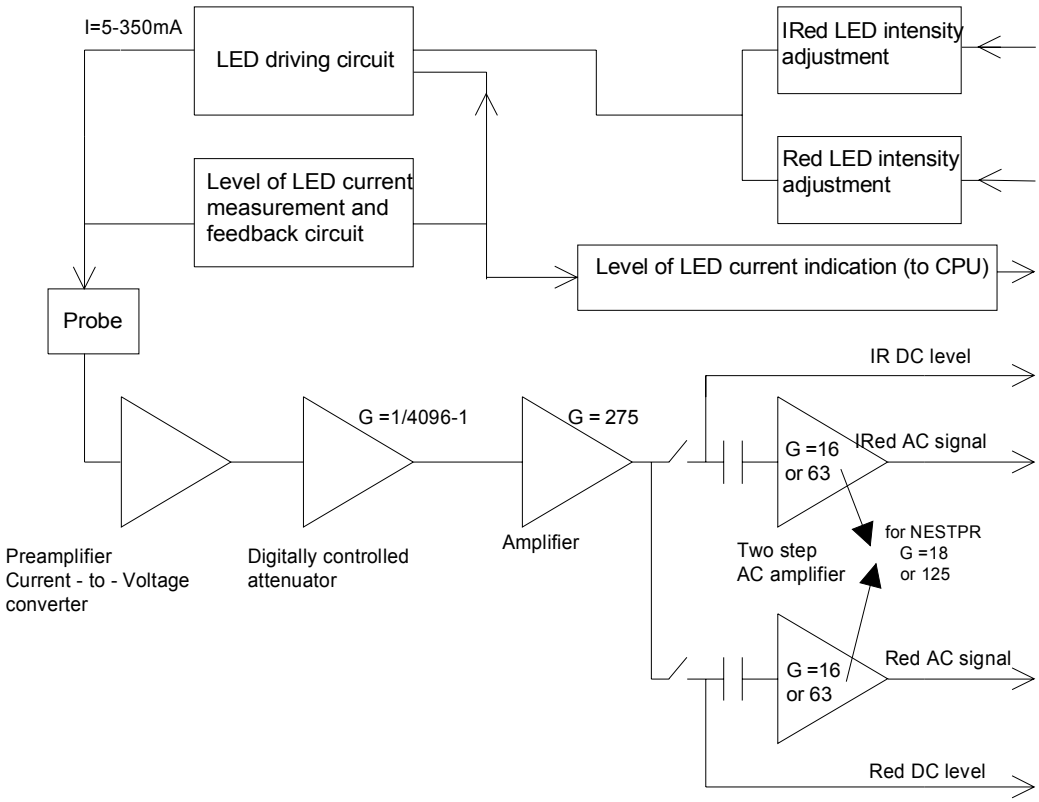


Figure 11 Pulse oximetry measurement block diagram

LED control signals

The processor sends pulse width modulated signals, IRED intensity and RED intensity, which are converted to DC voltage and filtered. By switches either RED or IRED intensity is sent forward to amplifier in LED driving circuit.

LED driving circuit

Voltage difference which corresponds to LED current, is measured by the differential amplifier circuit and its output is sent back to the processor in 0 to 5 V level. There are feedback circuits from LED current measurement and LED intensity control.

Background light is measured by picking up a sample from the signal. The sample is modified to 0 to 5 V level and sent to the processor.

Measured signal preamplification

Preamplifier is current-to-voltage converter with gain selection. The higher gain is used for measuring of thin tissue.

Digitally controlled amplifier

D/A converter is a digitally controlled amplifier after which there is another constant amplifier.

Red and infrared channel separation

Red and infrared channels are separated from each other by switches. Operational amplifier functions as a buffer and after this infrared DC signal is sent to the processor. A capacitor separates AC signal from it and the AC signal is sent to the processor after amplification. There is a switch to choose the amplification constant.

Serial communication

Serial communication between the module and the frame is done by RS485 type bus whose buffers get their supply voltage (+5 VDC) from the Frame and in the isolation section get the supply voltage (+5 V) from the isolated power supply.

The buffers of the serial communication are controlled also by Reset signal so that when the Reset is active, the buffer does not transfer data.

Reset is also RS485 type and additionally, there is an auxiliary logic power reset, which keeps the reset active for about 500 ms despite the state of reset in the module bus. Time constant determines the power-up reset time. There are components to prevent the module from sending data during reset. Data transmission rate is 500 kbps.

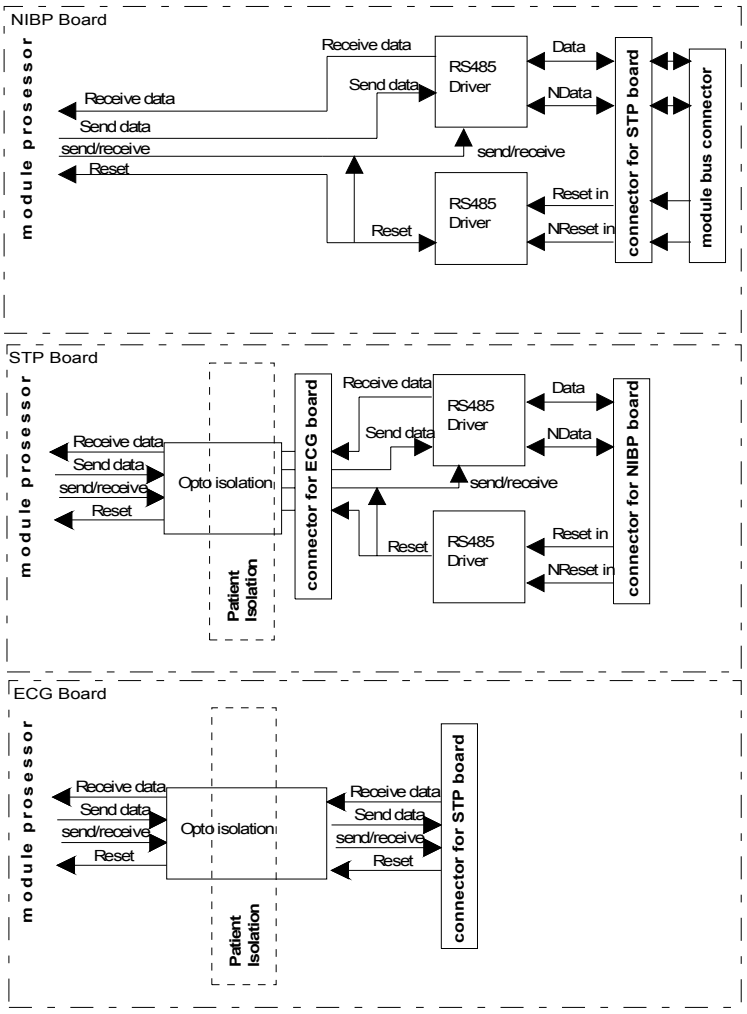


Figure 12 Serial communication and opto isolation of M-NESTPR/-NE12STPR

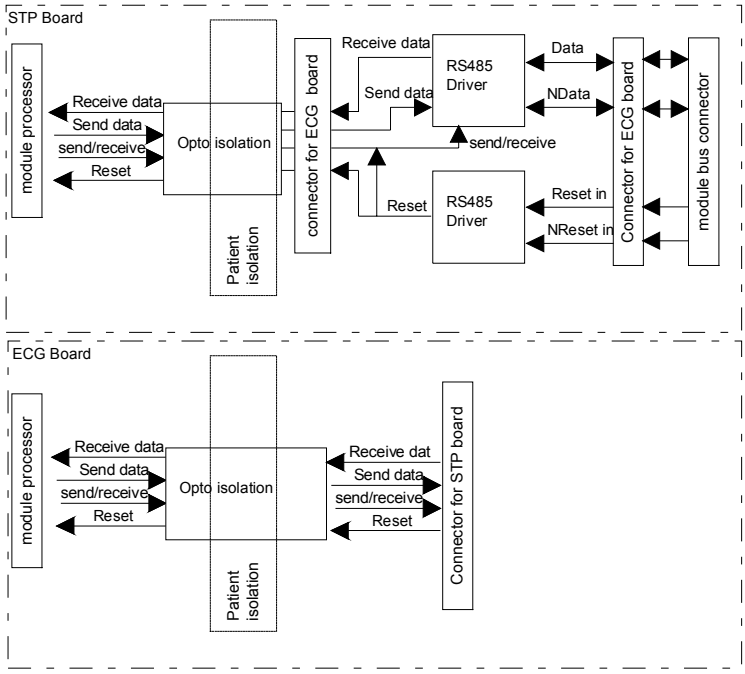


Figure 13 Serial communication and opto isolation of M-ESTPR

Isolated section

There are two opto isolators. Signal is processed on logical high-low level even though the outputs of the opto isolators are analog signals in the isolated section.

Reset line is an open collector type with a pull-up resistor. Thus the processor is able to use its internal watch-dog function.

Power supply section

Isolated supply voltage of the module is developed from +15 Vdirty voltage from the Central Unit. Power supply is a switched-mode circuit, where FET transistor switch is controlled by an oscillator using bipolar timer. The frequency of the oscillator is about 30 kHz and pulse ratio 50 %. Controlling of the FET switch is slowed to suppress spurious interference.

A special pulse transformer is used in the circuit. In the secondary circuit normal linear regulators are used except for +5 V (low drop type linear regulator).

2.3 Connectors and signals

2.3.1 Module bus connector

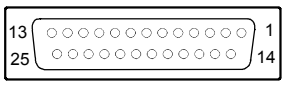


Figure 14 Module bus connector (X1) pin layout

Table 3 Module bus connector description

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	-DATA_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	

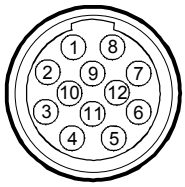
* = Not used

** = Used only by M-ESTPR, M-ETPR, M-ESTR and M-NIBP modules

2.3.2 Front panel connectors

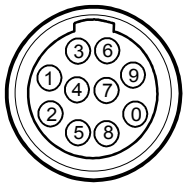
Table 4 Front panel connectors

12-lead ECG connector



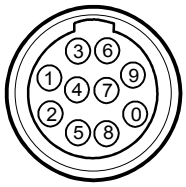
Pin No	Signal	Pin No	Signal
1	Right arm electrode (R)	7	Chest electrode (C3)
2	Left arm electrode (L)	8	Chest electrode (C4)
3	N	9	Chest electrode (C5)
4	Left leg electrode (F)	10	Chest electrode (C6)
5	Chest electrode (C1)	11	Cable type
6	Chest electrode (C2)	12	Ground

ECG connector (ECG)



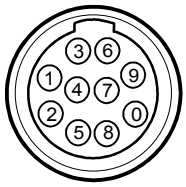
Pin No	Signal
1	Right arm electrode (R)
2	Left arm electrode (L)
3	Right leg electrode (RL)
4	Left leg electrode (F)
5	Chest electrode (C)
6	Cable shield
7	Not connected
8	3/5 lead identification
9	Lead connection check
10	Ground

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

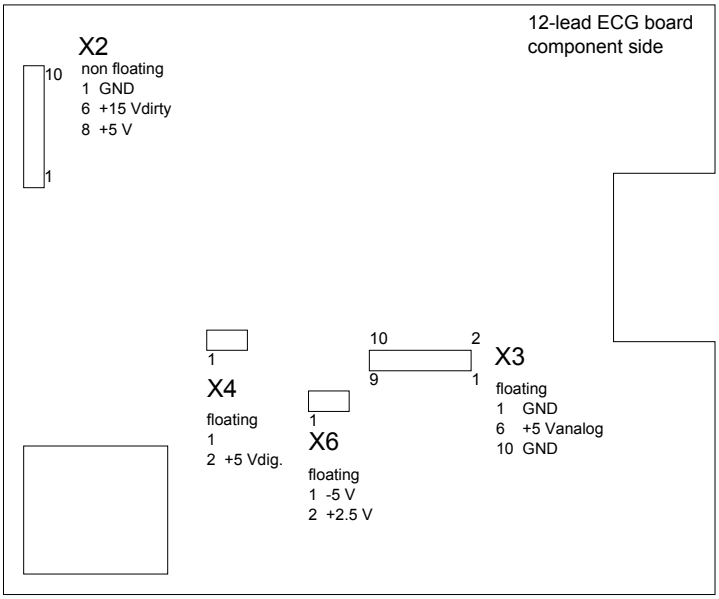
Invasive blood pressure connectors (P1, P2)



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

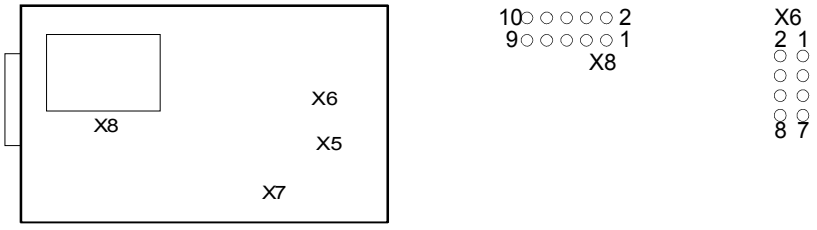
2.3.3 Test points on boards

12-lead ECG board



NIBP board

There are test pad blocks on solder side. X8 and X6 pads and voltages are:



X8	
Pin No	**Signal**
1	GND
2	WD out
3	reset
4	+5 V
5	+15 V dirty
6	+15 V
7	-15 V
8	-
9	-
10	GND

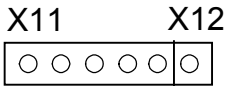
X6	
Pin No	**Signal**
1	GND
2	A1 output
3	- 5 V
4	+5 V ref
5	B1 out - (A1 input)
6	B1 out +
7	B2 out +
8	B2 out -

ECG and STP board

There are test pin blocks identical both on STP and ECG boards. Pins and voltages are as follows:

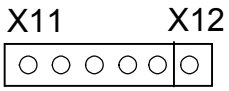
ESTPR

X11	pin 1	+5 Vref
	pin 2	+5 V
	pin 3	+12 V
	pin 4	Gnd
	pin 5	-12 V
X12	pin 1	-5 V (STP board only)



NESTPR

X11	pin 1	+5 Vref
	pin 2	+5 V
	pin 3	+7 V
	pin 4	Gnd
	pin 5	-7 V
X12	pin 1	-5 V (STP board only)



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.

CAUTION 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 service check. The service check is recommended to be performed after any service repair, however, the service check procedures can be used also for determining possible failures.

The procedures should be performed in ascending order.

The instructions include a check form (*Appendix A*) 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.

The procedures are designed for monitors with S/5 monitor software of revision 01. However, most of the procedures also apply to monitors, which contain some other monitor software type/revision.

3.2.1 Recommended tools

Tool	Order No.	Notes
Patient simulator	-	
Pressure manometer	-	
Temperature test set	884515	
3-lead ECG trunk cable		
5-lead ECG cable		
10-leadwire ECG cable		
SpO_2 finger probe	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 NE12STPR/NE12TPR/NE12STR/NESTPR/NETPR/NESTR 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 50 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 the front panel membrane key **ECG Lead** (not available in NE12STPR/NESTPR type modules).
Press the key at least for two seconds. Check that the selected ECG lead is changing on the screen and the state for 'Button' in the service menu.

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

10. @ M-ESTPR, M-ETPR , M-ESTR, M-NESTPR, M-NETPR and M-NESTR modules: connect a 5-lead ECG cable to the module. Check that the 'Cable type' shows 5 lead. If it shows 3 lead, make sure the used 5-lead ECG cable contains the necessary wiring for cable recognition (pins 0, 8 and 9 connected together).

    @ M-NE12STPR, M-NE12TPR and M-NE12STR modules: connect a 10-leadwire ECG cable to the module. 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. Connect a 3-lead ECG trunk cable without a lead set to the module. Check that the message "Leads off" is displayed on the screen.

12. 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, 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 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 NESTPR/ESTPR type modules and 5 lead cable the state of V2, V3, V4, V5 and V6 electrodes follow the state of the V electrode.

13. Connect the leads to a patient simulator.
    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. Check the lead selections by pressing the **ECG Lead** key on the module (not available in NE12STPR/NESTPR type modules).

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

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

14. 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 gives 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

15. Enter the ESTP : STP service menu:

    Parameters - ESTP : STP

    Check that the 'Timeouts', 'Bad checksums' and 'Bad c-s by mod' values are not increasing faster than by 50 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.

16. 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.

17. 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 *3.4.3 Temperature calibration*.

18. 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.

19. 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

20. Check the front panel membrane keys that are related to the InvBP or temperature 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.

21. 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.

22. Calibrate the InvBP channels P1 and P2 according to the instructions in the chapter *3.4.4. Invasive pressure calibration*

23. 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

24. 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.

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

Non Invasive Blood Pressure measurement

26. 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 50 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.

27. 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.

28. 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 Exh1***. Press the ComWheel and check that the pressure inside the tubing system starts to drop then press the ComWheel again. Check the other exhaust valve by the same way by selecting ***Open Exh2*** from the menu.
    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***.

29. 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 5 mmHg per one minute. Release the pressure by pressing the ComWheel once more.

30. Calibration check.

    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 ±10 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.

    Recalibrate the NIBP measurement according to the instructions in the chapter 3.4 Adjustment and calibration, *Calibration*, if necessary. Remember to set the calibration protection back on after the calibration.

31. Check the watchdog timer activation pressure.

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

    Keep the pressure manometer connected to the cuff connector. Pump up the pressure very slowly and note the value on the manometer when your hear a signal from the loudspeaker. The pressure at where the watchdog timer should activate with an audible signal is 7.5 mmHg (5...10 mmHg). Adjust the limit with the trimmer on the NIBP board, if necessary.

32. Check the watchdog timer.

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

    Check the watchdog timer in the adult mode. Activate the timer by highlighting ***Test ADULT*** and then pressing the ComWheel. Check that the time beside the text 'Watchdog Interval' starts to run. Wait until you hear a signal from the loudspeaker and then check the time again. The time from the adult test should fall within 120...140 seconds.

    Check the watchdog timer also in the infant mode by first selecting ***Test INFANT*** from the menu. The time from the infant test should fall within 60...70 seconds.

33. 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 290 - 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 154...165 mmHg.

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

34. 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 30 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 30 seconds.

    Check that automatic inflation limits are in use:

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

35. 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**.

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

37. 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

38. Perform electrical safety check and leakage current test.

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

40. Clean the module with suitable detergent.

- Fill in all necessary documents.

3.3 Disassembly and reassembly

3.3.1 M-ESTPR, M-ESTR, and M-ETPR modules

Disassemble the M-ESTPR/-ESTR/-ETPR module in the following way. See the exploded view of the module in 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, remove four screws, disconnect the ribbon cable from the STP board, and the ribbon cable from the front panel. Slide the board rearward to disconnect the fixed 10-pin connector from the ECG input board.
4. To detach the STP board, remove two screws and disconnect the two connectors from the SP input board. The T-input connector cables must be disconnected as well.

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

3.3.2 M-NE12STPR/-NE12STR/-NE12TPR/-NESTPR/-NESTR/-NETPR modules

Disassemble the M-NE12STPR/-NE12STR/-NE12TPR/-NESTPR/-NESTR/-NETPR module in the following way. See the exploded view of the module in 6.1.12.

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. The joining chamber can be detached by removing three screws and disconnecting the hoses from the pressure transducers and the pump. The pump can be detached by removing two screws. If the filter for the air inlet of the pump is removed, it must be replaced.

3.4 Adjustments and calibrations

3.4.1 Pressure safety level detection “OFFSET”

Remove two screws at the rear of the module. Remove the module box. Connect first the service cable (e.g. a long Gas Interface Cable) to the module connector inside the monitor frame and then to the rear connector of the module. Turn the monitor on. Enter to the NIBP service menu and select ***Pneumatics***. Pump reference pressure 7.5 mmHg into the module.
Adjust the trimmer until AD5 signal sign changes from negative to positive. Re-check the adjustement, then lock the trimmer with for example nail polish.

3.4.2 NIBP calibrations

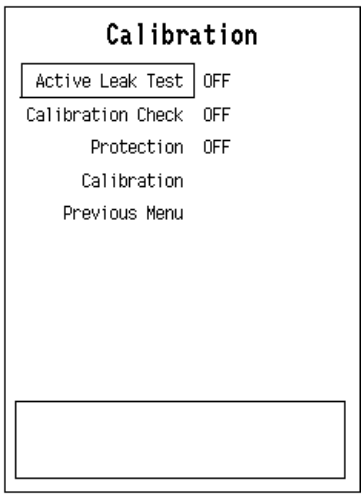
The electronics of NIBP pressure measurement is calibrated at the factory. Zeroing pressure is automatically maintained by the processor. If the zero point of the pressure transducer drifts more than specified, an error message is given and the NIBP board should be recalibrated or replaced.

The calibration can be checked and recalibrated 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.

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:

Table 5 NIBP calibration check pressures

Pressure	Max. error	Example
0 mmHg	±9 mmHg (=zero offset)	-2
100 mmHg	100 + zero offset ±2 mmHg	98 ±2
200 mmHg	200 + zero offset ±3 mmHg	198 ±2

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, it is recommended to recalibrate the module also 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. Turn the toggle switch at the bottom of the NIBP module to enable the calibration. Turn the switch to the right by, for example, a sharp pencil. This enables menu selection ***Protection***. The message 'Calibration switch ON!' appears.

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

C. Return the toggle switch to the left. 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 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 300 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 'Calibrating' will appear onto the NIBP digit field. After a few seconds it is followed by 'Calibrated', which means that the calibration has succeeded, and the new calibration data has been saved into EEPROM.

– To set the protection on:
Turn the toggle switch to the right. Select ***Protection ON*** and push the ComWheel. Then turn the toggle switch back to the left.

- Remove the module from the frame and plug it back again. Then perform ***Calibration check*** (see the preceding page) to verify the new calibration.

3.4.3 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 temperature when measured test values deviate more than ±0.1 °C, and always after STP board replacement.

1. Enter ESTPR: STP service menu.
2. Enter ***Calibrations*** menu.
3. Press the protect button at the bottom of the module and choose OFF in protect mode. Release the button.
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. Press in the protect button at the bottom of the module and choose ON in protect mode. Release the button.

3.4.4 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-NE(12)STPR module, module not properly connected, or NIBP and NE(12)STPR module connected at the same time.	Plug in the module.
Artifacts-message	Unsuccessful measurement due to patient movements or shivering.	
Weak pulsation-message	Weak or unstable oscillation pulses due to: • artifacts (accurate diastolic pressure difficult to measure) • marked arrhythmia • marked drop in diastolic pressure • diastolic pressure difficult to measure • improper cuff position or attachment • too few pulses detected • weak or unusual blood circulation • may give systolic value	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:	2.
	– 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
	– no pulses during the last three measurements	– check cuff positioning
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
	– air chamber leaking	–
	– tubes or valve(s) damaged	– replace tubes/valve(s)
Unable to measure Sys-message	Systolic blood pressure probably higher than the maximum inflation pressure.	Automatic retrial with increased pressure.

TROUBLE	CAUSE	TREATMENT
Cuff occlusion-message	1. Cuff and/or hose occluded. Reason:	1.
	– cuff tube kinked	– straighten tube
	– tube inside module kinked	– straighten tube
	– occlusion inside/outside module	– remove occlusion
	2. Cuff, hose, and tubes OK. Reason:	2.
	– fault in pressure transducer	– replace the NIBP board
	– fault in A/D converter	– replace the NIBP board
	– faulty calibration	– check calibration
	– missing voltages	– recalibrate
Calibration switch on - message	EEPROM protection switch at the bottom of the module is turned to right.	Enables setting the protection OFF in the Calibration menu. Turn switch to left 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 NIBP board.
1	ROM checksum error; memory failure	Change NIBP board.
2	+15 V failure	Check short circuits. Change NIBP board.
3	-15 V failure	Check short circuits. Change NIBP board.
4	EEPROM protection switch error (only with S-STD93)	Turn the toggle switch to the left at the bottom of the module.
5	Calibration not protected. (only with S-STD93)	Protect calibration by selecting Protection ON in the NIBP calibration menu.
6	ADC error	ADC circuit failure. Change NIBP board.
7	Watchdog time too short	Change NIBP board.
8	Watchdog time too long	Change NIBP board.
9	Watchdog activated	Change NIBP board.
10	EEPROM checksum error; memory failure	Change NIBP board.
11	Auto zero range exceeded	Calibrate NIBP.
12	Communication break; temporal break down of communication from monitor detected	Automatic recovery
13	-	-
14	Too early Auto Start (needs 25 seconds without pressure)	

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 to dry.

TROUBLE	CAUSE	TREATMENT
	2. Finger is too thin or thick.	2. Try other fingers, or other probe types.
Weak signal artifacts	Poor perfusion.	Try another place.
	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'	Modulation (Red or Ired) < 0.25 %	Patient may be cold.
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	Plug in
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-NE12STPR and M-NESTPR module troubleshooting

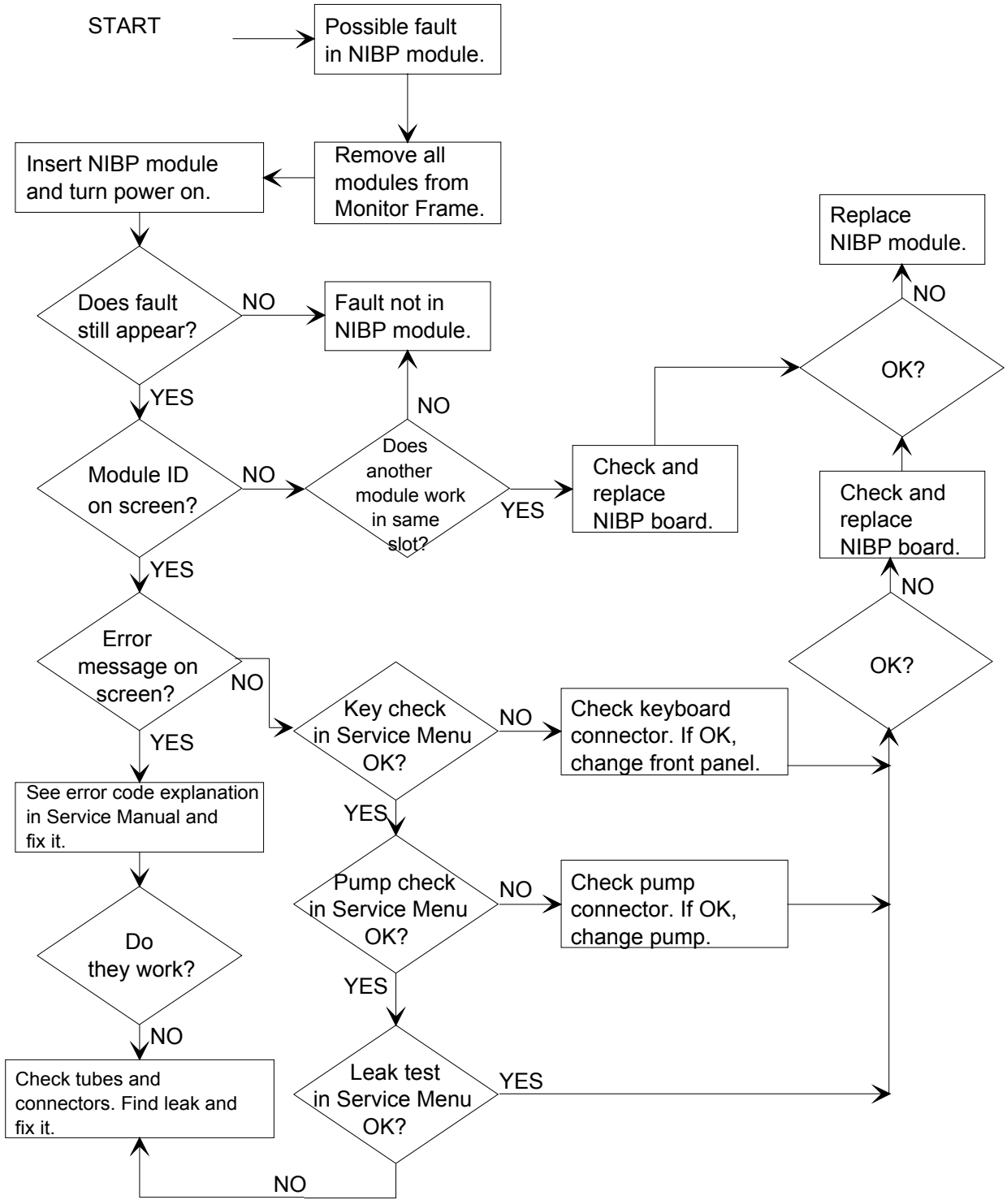


Figure 15 M-NE12STPR and M-NESTPR module troubleshooting flowchart

4.2.2 M-ESTPR, M-ESTR, and M-ETPR module troubleshooting

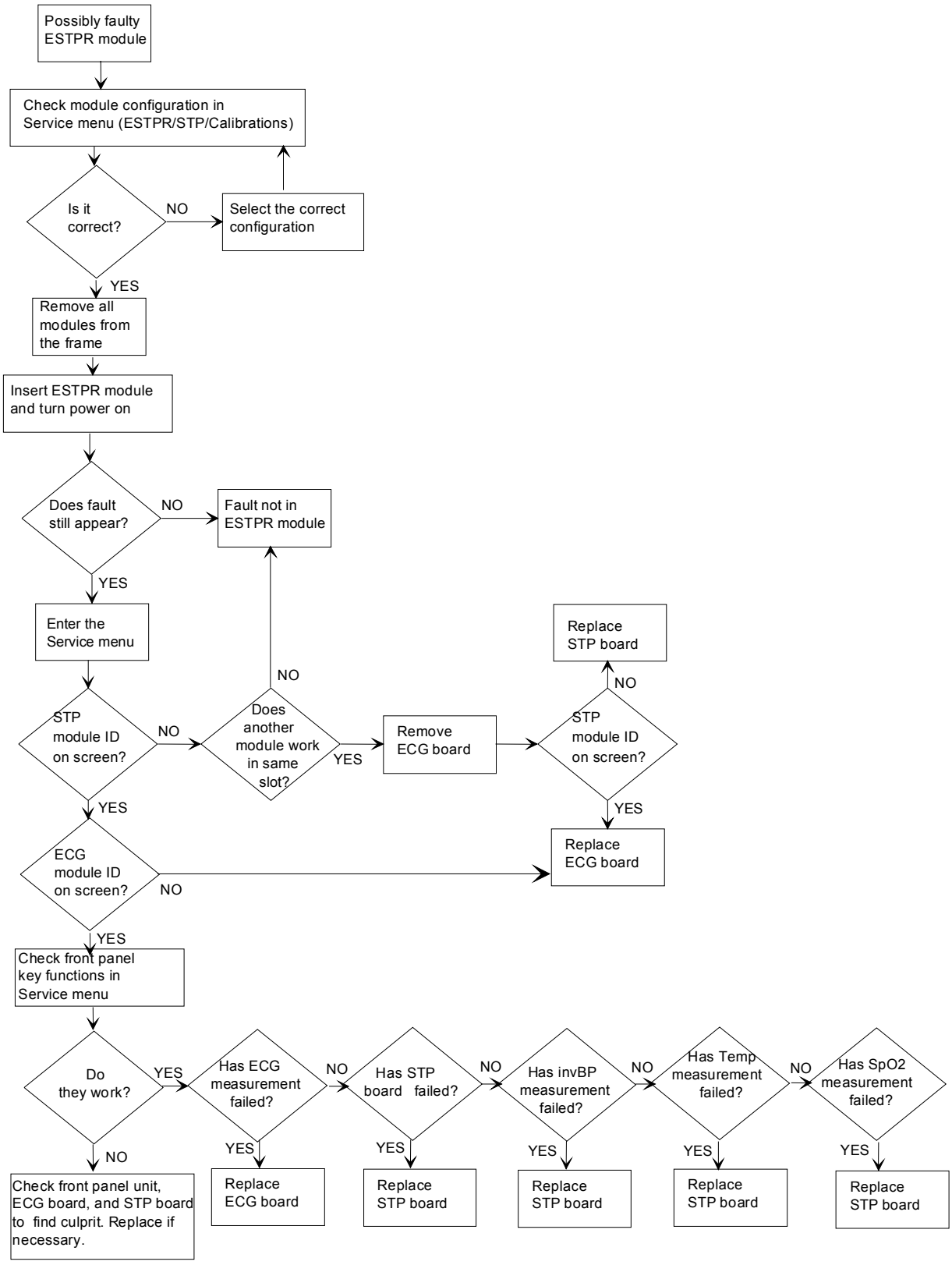
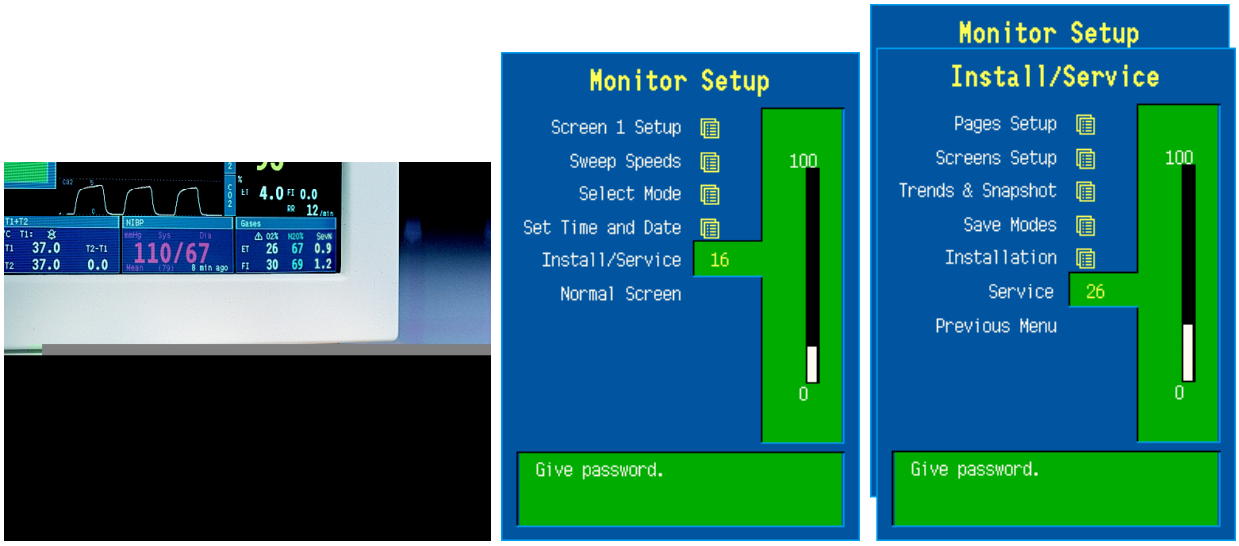


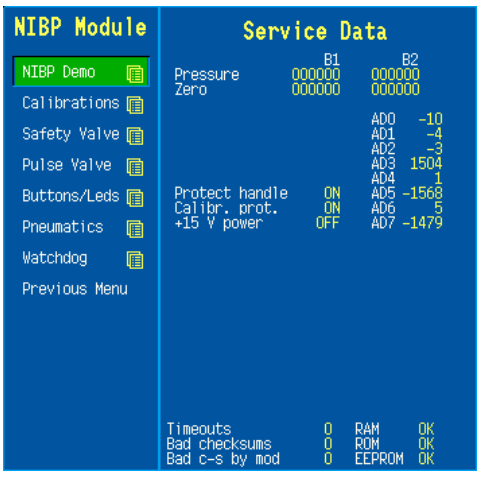
Figure 16 M-ESTPR Module Troubleshooting Flowchart

5 SERVICE MENU

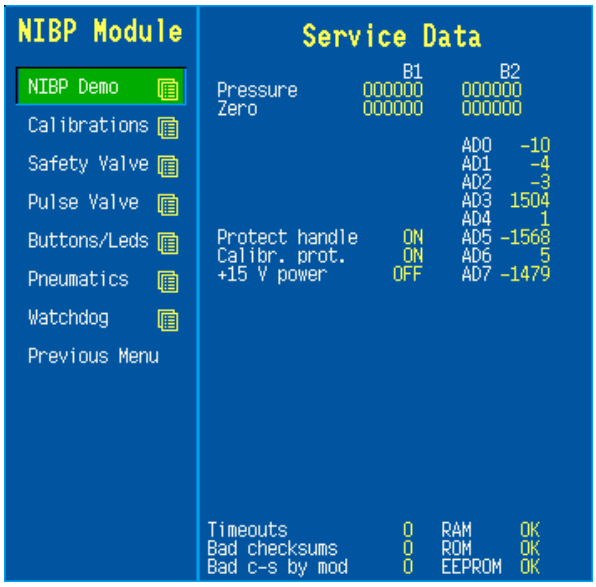


1. Press the **Monitor Setup** key.
2. Select ***Install/Service*** (password 16-4-34).
3. Select ***Service*** (password 26-23-8).
4. Select ***Parameters - NIBP***.

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.
Zero shows pressure at auto zeroing multiplied by 10 and changes between +20 and -20 mmHg. Absolute pressure is the sum of **Pressure** and **Zero**.

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 turning the toggle switch to the right at the bottom of the module, 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 indicates the condition of the supply voltage +15 Vdirty for the pump and valves. It exists (ON) or not (OFF) depending on service menu function. The supply voltage can be turned on by selecting the previous Menu and then the desired menu again.

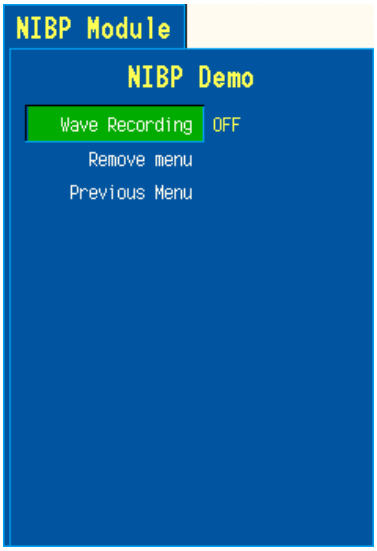
AD0 to **AD7** show the values of each eight channels of A/D converter.

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 50 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).

5.1.1 NIBP demo menu



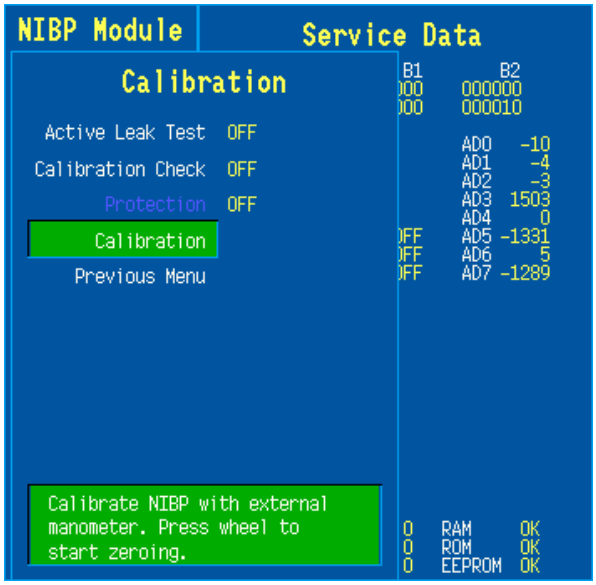
A service menu for demonstrating the oscillometric method of NIBP measurement. The menu shows the realtime pressure signals that are measured from the NIBP cuff. The measurement result is shown in the adjoining digit field.

Wave Recording **Wave Recording** is for selecting the recording option. If ON is selected, the pressure signals are recorded in realtime 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.

5.1.2 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 5 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), manually pump pressure into the module and make sure that the same pressure values are shown both on the display and on manometer. Pressure of both pressure channels B1 and B2 are shown. Note that if the display shows +2 mmHg at zero pressure and if you pumped +200 mmHg into the module, the display should show +202 mmHg.

Protection Software calibration protection (ON/OFF). Select OFF when calibrating. Protection can be set to ON or OFF only when the toggle switch at the bottom of the module is set to the right.

Calibration Calibration selection is available only when protection is OFF.

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 first turning the toggle switch to the right at the bottom of the module, which enables the **Protection** selection. Then turn the toggle switch to the left to enable **Calibration**.

NOTE : Do not disconnect the module from the frame when turning the switch. The module must be in the frame during the whole procedure.

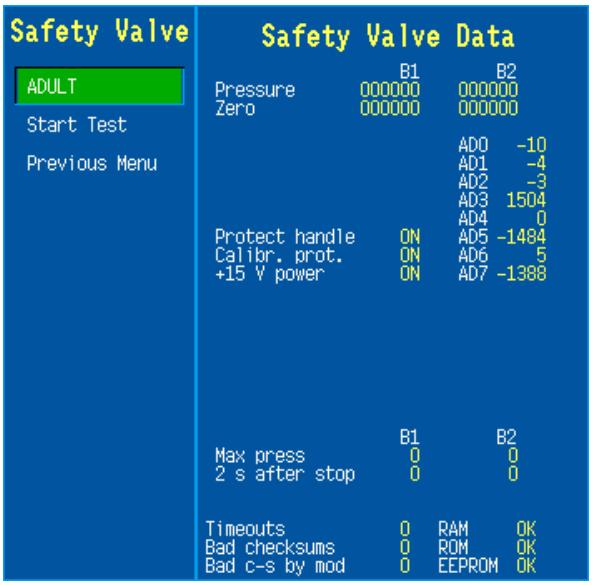
NOTE: When the switch is at the right, the NIBP field shows an error message ‘Calibration switch on!’.

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.

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. First the message 'Calibrating' will appear in the digit fields for NIBP followed after a few seconds 'Calibrated', which means that the calibration data has now been saved.
5. Use the bottom switch to enable **Protection** setting and set it ON, and finally disable **Protection** setting.

5.1.3 NIBP safety valve menu



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

Safety Valve Data

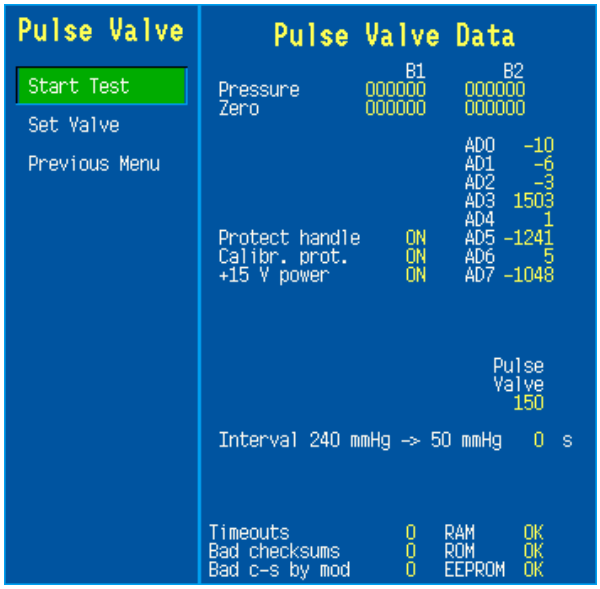
See NIBP Service menu in chapter 5.1 for information on general items **Pressure, Zero, Protect handle, Calibr. prot., +15 V power, AD0** to **AD7** as well as **Timeouts** etc.

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 310 ±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 > 280 mmHg for adult and > 120 mmHg for infant. If the value is less, check leakage by the active leak test.

5.1.4 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

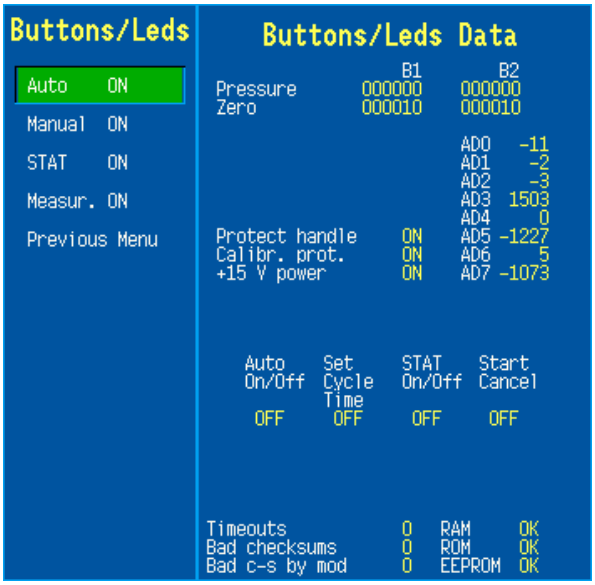
Wrap an adult cuff around a pipe and connect the cuff to the module. Select the **Start test** and push the ComWheel. The pressure rises beyond 240 mmHg and stops. The pulse valve opens. The module counts the time it takes for the pressure to go down from 240 mmHg to 50 mmHg and displays it on the screen.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

5.1.5 NIBP buttons/leds menu



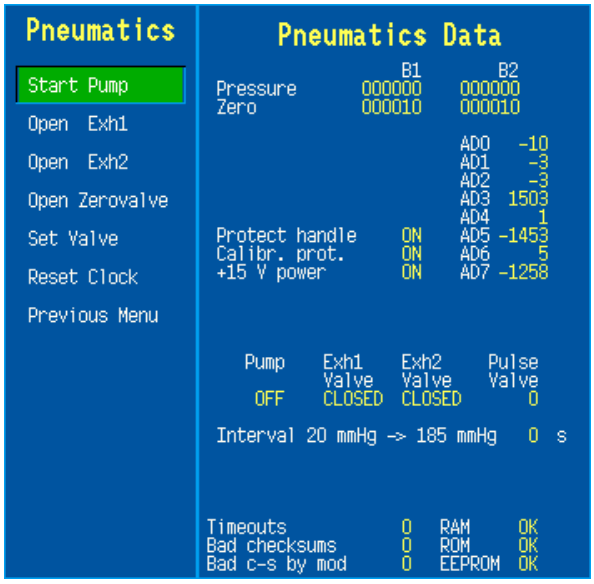
The selections ***Auto ON/OFF***, ***Manual ON/OFF***, ***STAT ON/OFF***, and ***Measur. ON/OFF*** have no effect on the module.

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 the key and observing OFF turns to ON at **Auto On/Off**, and **Start Cancel**.

5.1.6 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
A manual control for the exhaust valve 1. The selection changes to Close Exh1 when the valve is opened.

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

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.

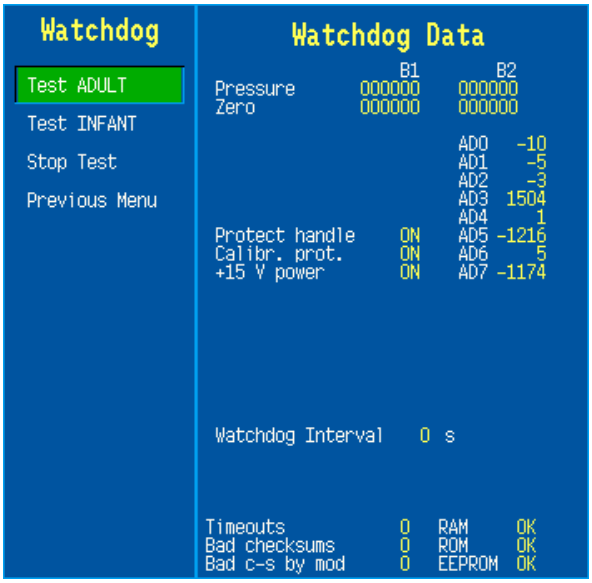
Pulse Valve shows how much the valve is opened (0 to 255) during Valve Setting.

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.

Watchdog BEEP
Connect manometer to the front panel and pump pressure into the module. When the AD5 value

changes from negative to positive value (at about 5 mmHg) a beep is heard. This is the watchdog threshold pressure. Beyond this pressure the watchdog is active and cut pressures at about 2 min. (adult).

5.1.7 NIBP watchdog menu



Test ADULT **Test ADULT** is to test watchdog timer in adult mode (120 to 140 seconds).

Test INFANT **Test INFANT** is to test watchdog timer in infant mode (about 60 to 70 seconds).

Stop Test Stop Test is for stopping the test.

Watchdog Data field

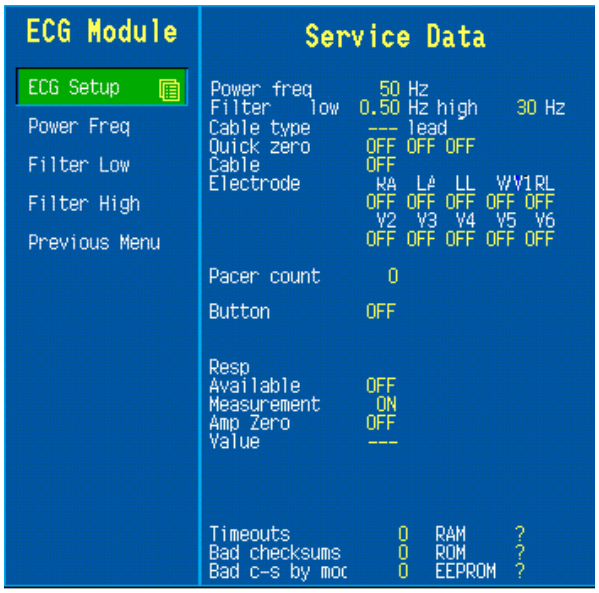
See NIBP Service menu in chapter 5.1 for information on general items **Pressure, Zero, Protect handle, Calibr. prot., +15 V power, AD0** to **AD7** as well as **Timeouts etc.**

Watchdog Interval shows the time the +15 Vdirty stays on during the test.

Adult watchdog time testing
Select ***Test ADULT*** and push the ComWheel. Watchdog interval starts counting up seconds and keeps on counting as long as the +15 Vdirty is on. The time should be 120 to 140 seconds.

Infant watchdog time testing
Select ***Test INFANT*** and push the ComWheel. Watchdog interval starts counting up seconds and keeps on counting as long as the +15 Vdirty is on. The time should be 60 to 70 seconds.

5.2 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 @ NESTPR and ESTPR modules is ON when the signal in any of the three internal amplifier goes beyond scale, and therefore, a capacitor connected to the related channel discharges overvoltage. At least one of **Quick zero** values is OFF when 3-lead cable is used. All three values are OFF when 5-lead cable is used. **Quick zero** also takes place when lead is changed in 3-lead measurement. @ NE12STPR **Quick zero** is on if any of the ECG amplifiers goes beyond the scale.

Cable shows ON when an ECG cable is connected.

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

The front panel ECG key function is confirmed by pressing the key and observing OFF turns to ON at **Button**.

NOTE: M-NE12STPR and M-NESTPR Module does not consist ECG key.

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

Measurement shows ON when the respiration measurement is on.

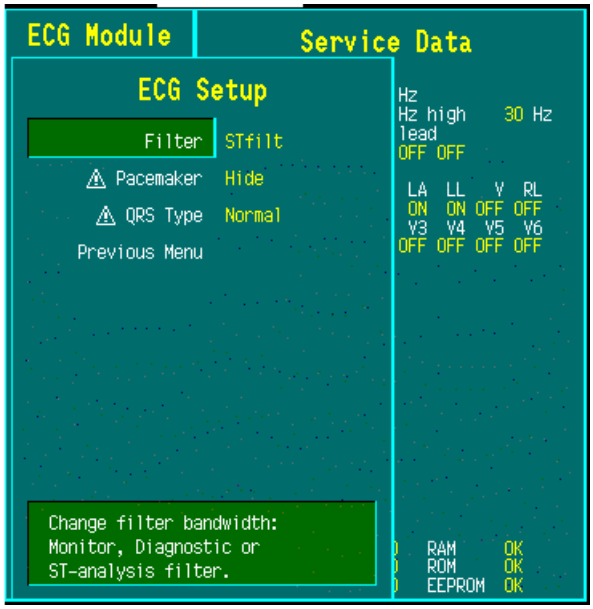
Amp zero shows ON when zeroing of the respiration amplifier takes place.

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 50 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).

5.2.1 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**.

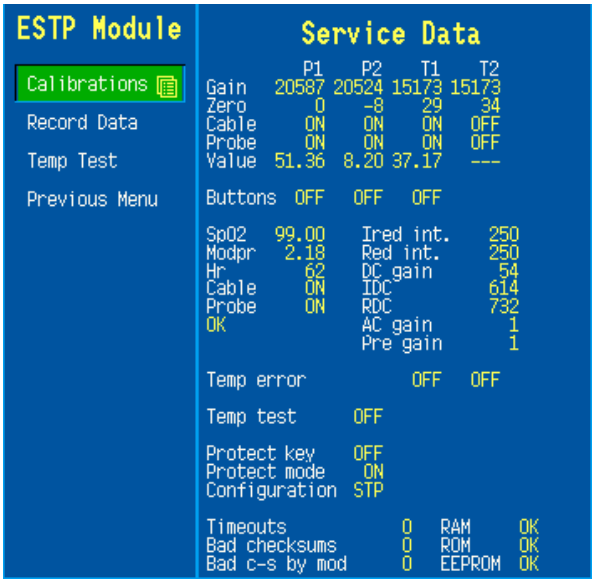
Hide, the pacing pulse is filtered away from ECG data.

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.

5.3 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...255 and red intensity (**red int.**)is in the range of 40...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 shows the status (OFF) and errors found (ON).

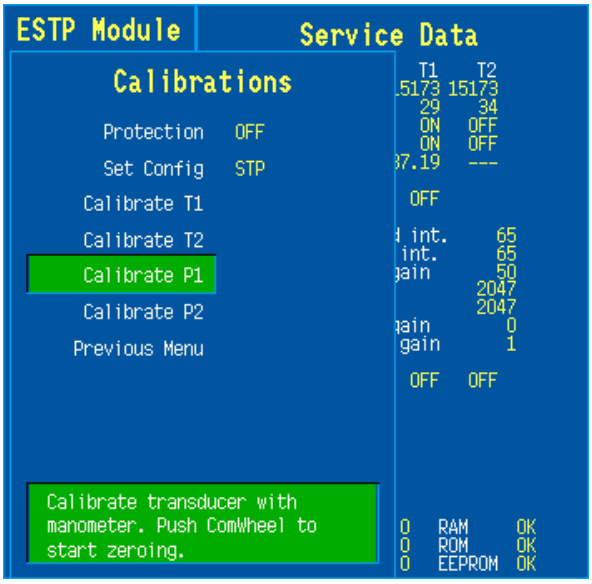
Protect key shows normally OFF but turns to ON when the button at the bottom of the module is pressed.

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 50 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).

5.3.1 STP calibration menu



Protection Protection for the configuration and temperature calibrations can be set ON and OFF only when protect button at the bottom of the module is pressed.

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.

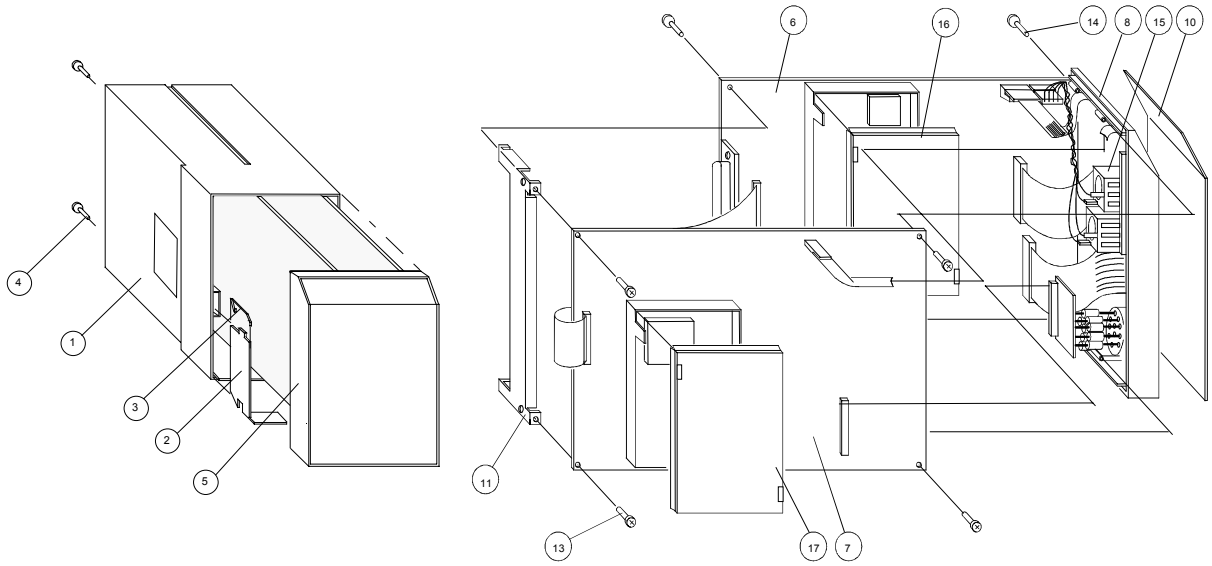
6 SPARE PARTS

6.1 Spare parts list

NOTE: Only changed part numbers are listed under later revisions. To find the desired part: check first the list of the revision that corresponds your device. If the part is not listed there, check the previous revision, etc. until you find the right number.

* stands for recommendation for stock.

6.1.1 M-ESTP rev. 01, M-ETP rev. 00, M-EST rev. 00



Item	Item description	Order no.
-	Membrane keypad	879374
1	Module box (wide)	886168
2	Spring pin	879182
3	Latch	879181
4	Cross recess screw M3x8 black	616215
5	Front panel unit, M-ESTP (rev. 01)	880337
5	Front panel unit, M-ETP (rev. 00)	880941
5	Front panel unit, M-EST (rev. 00)	880946
6	STP board, M-ESTP (rev. 01), M-P (rev. 00-01)	*880339
7	ECG board, M-ESTP (rev. 01)	*880338
11	Metal frame	879184
13	Cross cylinder-head screw M3x6	61721
14	Cross cylinder-head screw M3x12	628700

6.1.2 M-ESTP rev. 02, M-ETP rev. 01, M-EST rev. 01

Item	Item description	Order no.
6	STP board, M-ESTP (rev. 02)	*(882130) Use 882627, [1] 884342
7	ECG board, M-ESTP (rev. 02)	*(882025) Use 888957, [2] 883806
8	Front panel unit, M-ESTP (rev. 02-03)	882127
8	Front panel unit, M-ETP (rev. 01-02)	882128
8	Front panel unit, M-EST (rev. 01-02)	882129
15	T-input board, M-ESTP (rev. 02-03)	*882090

6.1.3 M-ESTP rev. 03, M-ETP rev. 02, M-EST rev. 02

Item	Item description	Order no.
-	EMC plate	884099
6	STP board, M-ESTP (rev. 03-05), M-P (rev. 02)	*882627
7	ECG board, M-ESTP (rev. 03)	*(883119) Use 888957, [2] 883806

6.1.4 M-ESTP rev. 04, M-ETP rev. 03, M-EST rev. 03

Item	Item description	Order no.
-	ECG software	*883806
D4	STP software	*884342
7	ECG board, M-ESTP (rev. 04)	*(886748) Use 888957
8	Front panel unit, M-ESTP (rev. 04-05)	887153
8	Front panel unit, M-ETP (rev. 03-04)	887154
8	Front panel unit, M-EST (rev. 03-04)	887155
15	T-input connectors, M-ESTP (rev. 04-05)	*887152
16	EMC cover	884099

6.1.5 M-ESTP rev. 05, M-ETP rev. 04, M-EST rev. 04

Item	Item description	Order no.
7	ECG board, M-ESTP (rev. 05)	*888957

A front panel unit includes all the connectors and input boards.

[1] NOTE: The STP board 882627 can be used as a replacement only with STP software 884342.

[2] NOTE: The ECG board 888957 can be used as a replacement only with ECG software 883806.

6.1.6 M-ESTPR rev. 01, M-ETPR rev. 01, M-ESTR rev. 01

Item	Item description	Order no.
-	Membrane keypad	879374
1	Module box (wide)	886168
2	Spring pin	879182
3	Latch	879181
5	Cross recess screw M3x8 black	616215
6	STP board, M-ESTP (rev. 03-05), M-P (rev. 02)	*882627
7	ECG/RESP board, M-ESTPR (rev. 01)	*(884609) Use 888956
8	Front panel unit, M-ESTPR (rev. 01-02)	887153
8	Front panel unit, M-ETPR (rev. 01-02)	887154
8	Front panel unit, M-ESTR (rev. 01-02)	887155
11	Metal frame	879183
13	Cross cylinder-head screw M3x6	61721
14	Cross cylinder-head screw M3x12	628700
15	T-input connectors, M-ESTP (rev. 04-05)	*887152
16	EMC cover	884099
17	EMC cover	886818

6.1.7 M-ESTPR rev. 02, M-ETPR rev. 02, M-ESTR rev. 02

Item	Item description	Order no.
7	ECG/RESP board, M-ESTPR (rev. 02)	*888956

A front panel unit includes all the connectors and input boards.

6.1.8 M-ESTPR rev. 03, M-ETPR rev. 03, M-ESTR rev. 03

Item	Item description	Order no.
6	STP board	*(891442) use 8002575
8	Front panel unit, M-ESTPR	894161
8	Front panel unit, M-ESTR	894162
8	Front panel unit, M-ETPR	894163
	ECG board	*889988
	ECG input board	*889985

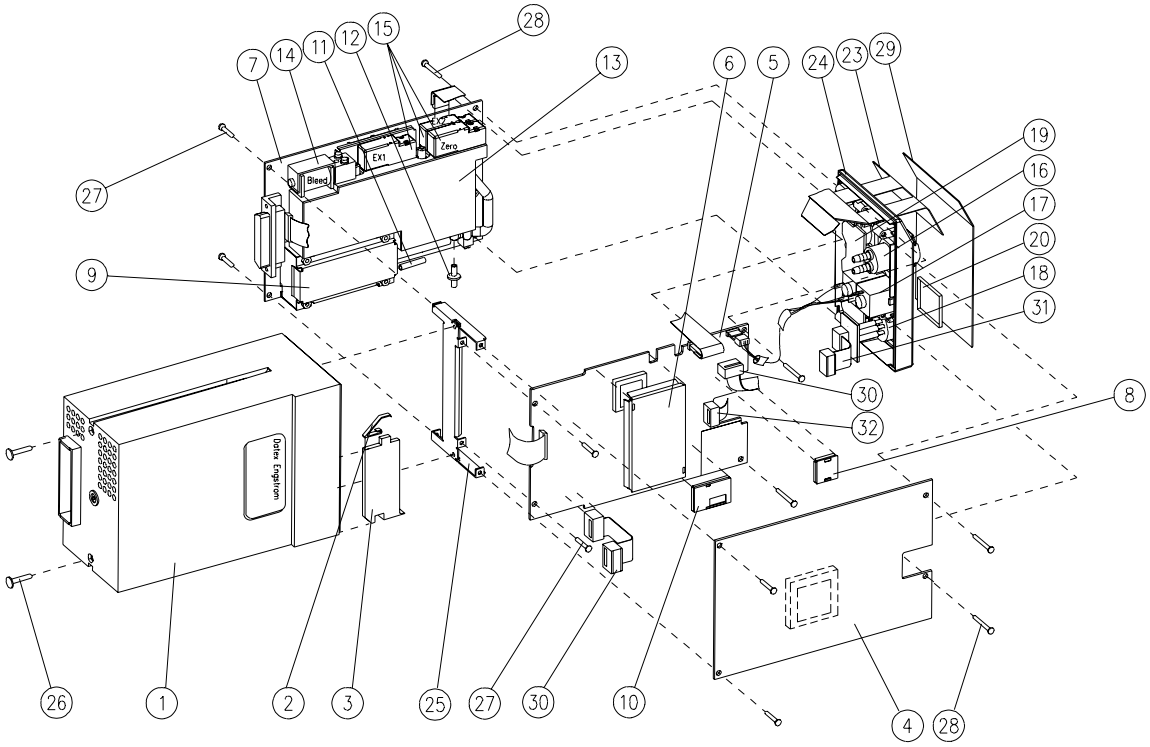
NOTE: The STP board 891442 can be used as a replacement only with STP software 891401.

6.1.9 M-ESTPR rev. 04, M-ETPR rev. 04, M-ESTR rev. 04

Item	Item description	Order no.
6	STP board	8002575

NOTE: The STP board 8002575 includes the STP software 8000717.

6.1.10 M-NESTPR rev. 00, M-NETPR rev. 00, M-NESTR rev. 00



Item	Item description	Order no.	Item	Item description	Order no.
1	Module box (wide)	886168	17	T input connectors	*887152
2	Spring pin	879182	18	ECG input board, M-NESTPR (rev. 00)	889985
3	Latch	879181	19	SP input board, M-NESTPR (rev. 00)	890006
4	ECG/RESP board, M-NESTPR (rev. 00)	*889988	19	SPO2 input board, M-NESTR (rev. 00)	890833
5	STP board, M-NESTPR (rev. 00)	*(890007) use 8002574	19	P input board, M-NETPR (rev. 00)	890834
6	EMC cover	884099	20	Fitting plate	879510
7	NIBP board, M-NESTPR (rev. 00)	*887520	23	Membrane keypad	888242
8	EMC cover	892305	24	Front panel unit, M-NESTPR M-NESTR M-NETPR	888273 891748 891772
9	NIBP pump, M-NESTPR	*889993	25	Metal frame	888230
10	EMC cover	892307	26	Cross recess screw M3x8 black	616215
11	NIBP pump filter	*57142	27	Cross cylinder-head screw M3x6	61721
13	Damping chamber, M-NESTPR	888240	28	Cross cylinder-head screw M3x12	628700
14	Bleed valve, M-NESTPR	58566	30	Flat cable, STP	890874
15	Magnetic valve	58562	31	Flat cable, ECG	890876
16	Hose connector	64654	32	Flat cable, PP	891573

A front panel unit includes all the connectors and input boards.

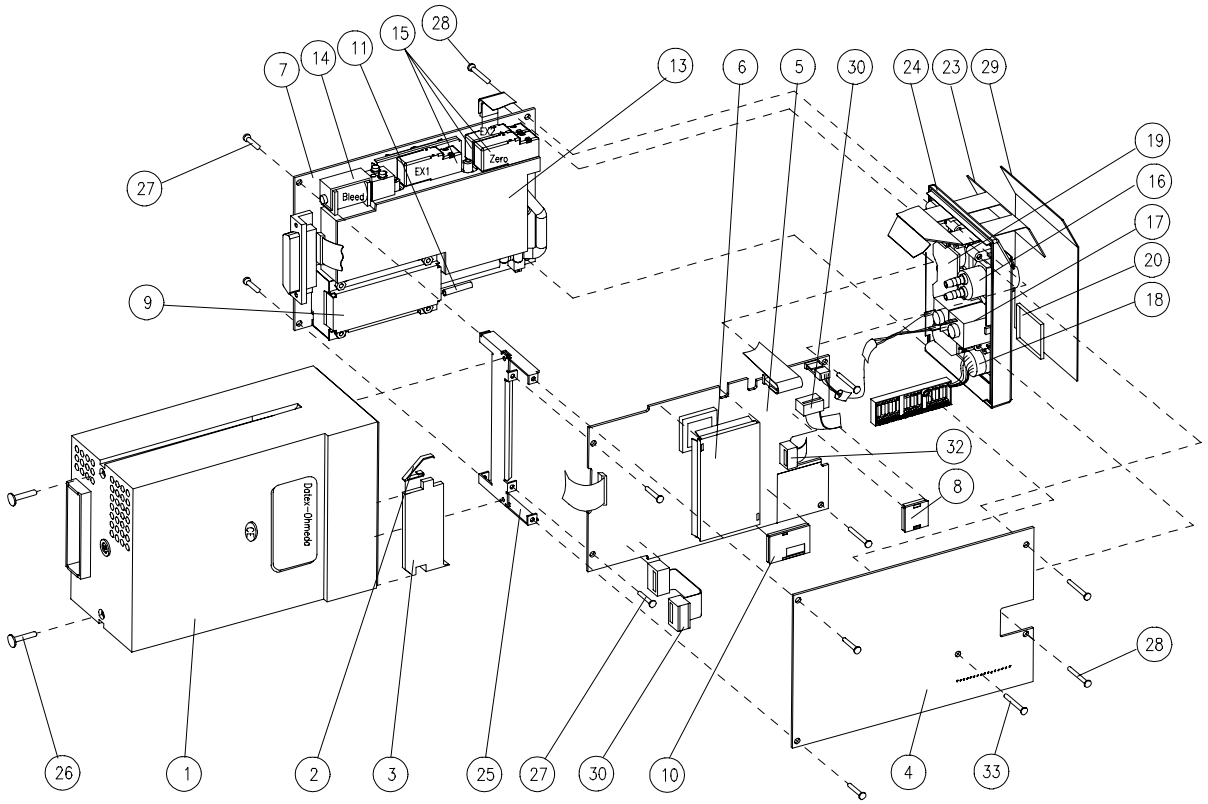
NOTE: The STP board 890007 can be used as a replacement only with STP software 891401.

6.1.11 M-NESTPR rev. 01, M-NETPR rev. 01, M-NESTR rev. 01

Item	Item description	Order no.
5	STP board, M-NESTPR (rev. 01)	8002574

NOTE: The STP board 8002574 includes the STP software 8000717.

6.1.12 M-NE12STPR rev. 00, M-NE12STR rev. 00, M-NE12TPR rev. 00



Item	Item description	Order no.
4	ECG board	*894284
18	ECG input board	*896913
24	Front panel unit, M-NE12STPR	896910
24	Front panel unit, M-NE12STR	896911
24	Front panel unit, M-NE12TPR	896912
33	Screw	61719

6.1.13 M-NE12STPR rev. 01

Item	Item description	Order no.
5	STP Board	8002574

6.1.14 Front panel stickers

Front panel stickers that are related to the Compact Module type and adaptation:

Adaptation codes: DA=Danish, DE=German, EN=English, ES=Spanish, FI=Finnish, FR=French, IT=Italian, JA=Japanese, NL=Dutch, NO=Norwegian, PT=Portuguese, SV=Swedish

Item no. 10 or 29

Adaptation	M-ESTP (rev. 01) Order No.	M-ETP (rev. 00) Order No.	M-EST (rev. 00) Order No.
DE	880552	880560	880453
EN	879481	880428	880138
FR	880158	880429	880140

Adaptation	M-ESTP (rev. 02 -->) Order No.	M-ETP (rev. 01 -->) Order No.	M-EST (rev. 01 -->) Order No.
DE	881955	881958	881961
EN	881953	881956	881959
ES	884200	885043	885044
FR	881954	881957	881960
IT	886753	886754	886755
NL	886044	886046	886045
SV	885857	885856	885859

Adaptation	M-ESTPR (rev. 01-03) Order No.	M-ETPR (rev. 01-03) Order No.	M-ESTR (rev. 01-03) Order No.
DA	892207	892209	892208
DE	886966	886967	886968
EN	886603	886604	886605
ES	886943	886944	886945
FI	888868	888869	888870
FR	886963	886965	886964
IT	886925	886926	886927
JA	888303	888305	888304
NL	886937	886938	886939
NO	893554	893555	893556
PT	895249	895251	895250
SV	886928	886929	886930

Adaptation	M-NESTPR (rev. 00) Order No.	M-NETPR (rev. 00) Order No.	M-NESTR (rev. 00) Order No.
DA	892204	892206	892205
DE	891166	891678	891671
EN	889264	891457	891456
ES	891171	891681	891674
FI	891170	891683	891676
FR	891167	891679	891672
IT	891172	891682	891675
JA	894963	894965	894964
NL	891168	891680	891673
NO	893566	893567	893568
PT	895234	895236	895235
SV	891169	891684	891677

Adaptation	M-NE12STPR (rev. 00) Order No.	M-NE12STR (rev. 00) Order No.	M-NE12TPR (rev. 00) Order No.
DA	897718	897622	897655
DE	897709	897613	897646
EN	896985	896986	896987
ES	897712	897616	897649
FI	897715	897619	897652
FR	897710	897614	897647
IT	897713	897617	897650
JA	897719	897623	897656
NL	897711	897615	897648
NO	897717	897621	897654
PT	897714	897618	897651
SV	897716	897620	897653

6.1.15 Front panel stickers for S/5 modules

Front panel stickers that are related to the Compact Module type and adaptation:

Adaptation codes: DA=Danish, DE=German, EN=English, ES=Spanish, FI=Finnish, FR=French, IT=Italian, JA=Japanese, NL=Dutch, NO=Norwegian, PT=Portuguese, SV=Swedish

Adaptation	S/5 M-ESTPR (rev. 04) Order No.	S/5 M-ETPR (rev. 04) Order No.	S/5 M-ESTR (rev. 04) Order No.
DA	898504	898578	898565
DE	898495	898569	898556
EN	898494	898568	898555
ES	898498	898572	898559
FI	898501	898575	898562

FR	898496	898570	898557
IT	898499	898573	898560
JA	898505	898579	898566
NL	898497	898571	898558
NO	898503	898577	898564
PT	898500	898574	898561
SV	898502	898576	898563

Adaptation	**S/5 M-NESTPR (rev. 01) Order No.**	**S/5 M-NETPR (rev. 01) Order No.**	**S/5 M-NESTR (rev. 01) Order No.**
DA	898429	898492	898458
DE	898420	898483	898449
EN	898419	898482	898448
ES	898423	898486	898452
FI	898426	898489	898455
FR	898421	898484	898450
IT	898424	898487	898453
JA	898430	8000380	898459
NL	898422	898485	898451
NO	898428	898491	898457
PT	898425	898488	898454
SV	898427	898490	898456

Adaptation	**S/5 M-NE12STPR (rev. 01) Order No.**	**S/5 M-NE12STR (rev. 01) Order No.**	**S/5 M-NE12TPR (rev. 01) Order No.**
DA	898442	898470	898481
DE	898433	898461	898472
EN	898432	898460	898471
ES	898436	898464	898475
FI	898439	898467	898478
FR	898434	898462	898473
IT	898437	898465	898476
JA	8000377	8000378	8000379
NL	898435	898463	898474
NO	898441	898469	898480
PT	898438	898466	898477
SV	898440	898468	898479

7 EARLIER REVISIONS

For service information on the earlier revisions, please refer to:

Module revision	Manual	Note!
ESTP Module revision 01	Service Manual p/n 880850	
ETP Module revision 00	Service Manual p/n 880850	
ESTP Module revision 02	Service Manual p/n 882580	
ETP and EST Modules revision 01	Service Manual p/n 882580	
ESTP Module revision 03-04, and ETP and EST Modules revision 02-03 NE12STPR Module, M-NE12STPR (rev. 00) NE12STR Module, M-NE12STR (rev. 00) NE12TPR Module, M-NE12TPR (rev. 00) NESTPR Module, M-NESTPR (rev. 00) NESTR Module, M-NESTR (rev. 00) NETPR Module, M-NETPR (rev. 00) ESTPR Module, M-ESTPR (rev. 03) ESTR Module, M-ESTR (rev. 03) ETPR Module, M-ETPR (rev. 03)	Technical Reference Manual Slot 896620-1.	Main manual is 896 624.

APPENDIX A

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SERVICE CHECK FORM

DATEX-OHMEDA HEMODYNAMIC MODULES

Customer _____

Service _____

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. Membrane key	☐	☐	☐
9. Power frequency	☐	☐	☐	10. Cable recognition	☐	☐	☐
11. Lead detection	☐	☐	☐	12. Test with patient simulator	☐	☐	☐

Notes _____

RESP measurement S/N

	OK	N.A.	Fail		OK	N.A.	Fail
13. RESP measurement recognition	☐	☐	☐	14. Test with patient simulator	☐	☐	☐

Notes

TEMP measurement S/N

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

Notes

InvBP measurement S/N

	OK	N.A.	Fail		OK	N.A.	Fail
20. Membrane keys	☐	☐	☐	21. Cable and transducer detection	☐	☐	☐
22. Calibration	☐	☐	☐	23. Test with patient simulator	☐	☐	☐

Notes

SpO_2 measurement S/N

	OK	N.A.	Fail		OK	N.A.	Fail
24. SpO_2 probe detection	☐	☐	☐	25. Test measurement	☐	☐	☐

Notes

NIBP measurement S/N

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

29. Leak test		≤ 5 mmHg/min

30. Calibration check

	Measured B1	Measured B2	Allowed range
0 mmHg			± 9 mmHg
100 mmHg			100 + z.o. ± 2 mmHg
200 mmHg			200 + z.o. ± 3 mmHg
260 mmHg			260 + z.o. ± 4 mmHg

z.o. = zero offset at 0 mmHg pressure

31. Watchdog timer activation pressure		5...10 mmHg

32. Watchdog timer

Adult		120...140 s
Infant		60...70 s

33. Safety valve functions

	B1	B2	Allowed range
'Max press' ADULT			290...330 mmHg
'2 s after stop' ADULT			290...330 mmHg
'Max press' INFANT			154...165 mmHg
'2 s after stop' INFANT			154...165 mmHg

	OK	N.A.	Fail		OK	N.A.	Fail
34. Cuff related messages	☐	☐	☐	35. Adult cuff detection	☐	☐	☐
36. Test measurement	☐	☐	☐	37.Infant cuff detection	☐	☐	☐

Notes _____

All modules

	OK	N.A.	Fail		OK	N.A.	Fail
38. Electrical safety check	☐	☐	☐	39. Functioning after electrical safety check	☐	☐	☐
40. Final cleaning	☐	☐	☐				

Notes _____

Notes _____

_____

Used Spare Parts _____ _____ _____

_____ _____ _____

Signature _____