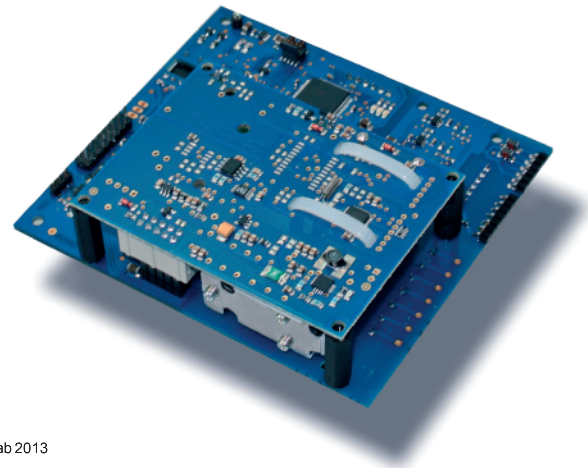
medlab

Multiparameter OEM Board
for Patient Monitors

MP01000

Technical Manual



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Introduction

This document describes the hardware and the firmware interface of Medlab's multiparameter patient monitoring board, the MP01000.
The module can be used to construct a patient monitor to be used from neonate to adult, while concentrating on housing, design and user interface. The MP01000 handles the complete interface to the patient, in a safe and certifiable way.
The MP01000 is not a final medical product and carries no CE mark. The module will not hinder you to confirm with the current relevant standards, but also the part of the system added by the user has to be designed in a way, so that the complete product can be CE marked, FDA registered, or safety tested in a test lab.

Glossary

ECG	Electrocardiogram
Lead	Connection to the patient and one ECG electrode
Channel	Waveform showing the differential voltage between two or more electrodes
BPM	Beats per minute (1/min). Unit used to display pulse rates
RPM	Respirations per minute (1/min). Unit used to display respiration rate
SpO_2	Saturation pulsatile O_2 - the arterial oxygen saturation in %, measured by a pulse oximeter
NIBP	Non invasive blood pressure, measured by a cuff around the upper arm
YSI400	The family of standardized temperature probes used for body temperature measurement
UART	Universal Asynchronous Receiver Transmitter - Interface type
CAN	Controller Area Network - Interface type

Physical Units of Transmitted Data

Transmission speeds for the waves are indicated in Hz (sec^{-1}).
Scaling of ECGs is done in the units "cm/mV" for the Y-axis and in "mm/sec" for the X-axis.

Standard values for the trace speed are 12.5 mm/sec, 25 mm/sec and 50 mm/sec. The amount of points needed to reach these speeds depend on the resolution of the user screen. For example, if one uses an LCD screen with a resolution of 4 dots/mm, a data rate of 100 Hz is needed to show the waveform with 25 mm/sec.

ECG amplitudes are typically indicated in „cm/mV“. Since this is directly depending on the resolution of the screen the user is working on, the transmitted samples cannot be scaled like this, but instead fall into the range of 0-0xFF. It is within the responsibility of the user to scale the transmitted samples in a way so the waves displayed on his individual screen fit to the usual scales used in medicine, 0.5, 1, 2, and 4 cm/mV.

The amplification of the module in the different amplification stages is:

Stage 1	Stage 2	Stage 3	Stage 4
1mV = 32	1mV = 64	1mV = 128	1mV = 256

Respiration rate is transmitted in „rpm“ (respirations per minute).

Pulse rate is transmitted in „bpm“ (beats per minute).

Pressures for NIBP are transmitted in mmHg (1mmHg = 133,322 Pascal)

Temperatures are transmitted in 10*°C, e.g. 388 equals 38.8 °C

Overview

The MP01000 contains a five lead ECG, a pulse oximeter, a part for measuring a patient's arterial blood pressure, none-invasively, and a two channel thermometer.

The module can work with a five lead ECG cable to show 7 channels of ECG, with a four lead cable showing 6 channels, and with a three lead cable to show one channel of ECG. An advanced pulse detection algorithm is integrated.

The module measures the respiration rate of the patient using the impedance change between the electrodes.

When using a five lead cable, the module can output the following channels synchronously: I, II, III, aVR, aVL, aVF, C.

When using a four lead cable, the module can output the following channels synchronously: I, II, III, aVR, aVL, aVF.

When using a three lead cable, the module can output the following channels: I or II or III.

The non-invasive blood pressure measurement is done using a standard cuff, normally fitted on the left upper arm of the patient. There are six different cuff sizes available.

SpO_2 is measured using an optical transducer that is attached to the patient's finger. Medlab offers a complete family of transducers, reusable - and single use types, for adults and neonates.

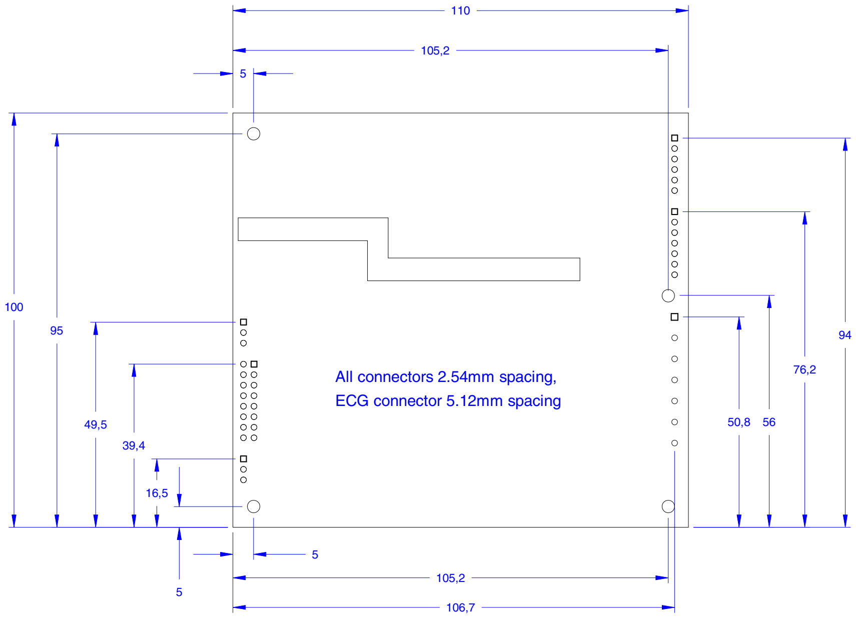
Temperature is measured using standard YSI400 family temperature probes.

The MP01000 contains all patient-side electronics needed for a complete and small medical multi-parameter monitor.

The module communicates with a host over a bidirectional serial interface, either of UART or CAN type. The MP01000 receives commands from the host and streams the measured patient data back to the host microcontroller. Both sides of the protocol are block oriented and secured by a CRC checksum present in the data blocks.

Since the module generates a relatively large amount of data, a powerful 32 bit host microcontroller is required. For example, ARM Cortex M3 or Cortex M4 controllers are very well suited to receive and decode the data stream and also eventually control a user interface on a colour LCD or similar.

Mechanical Dimensions

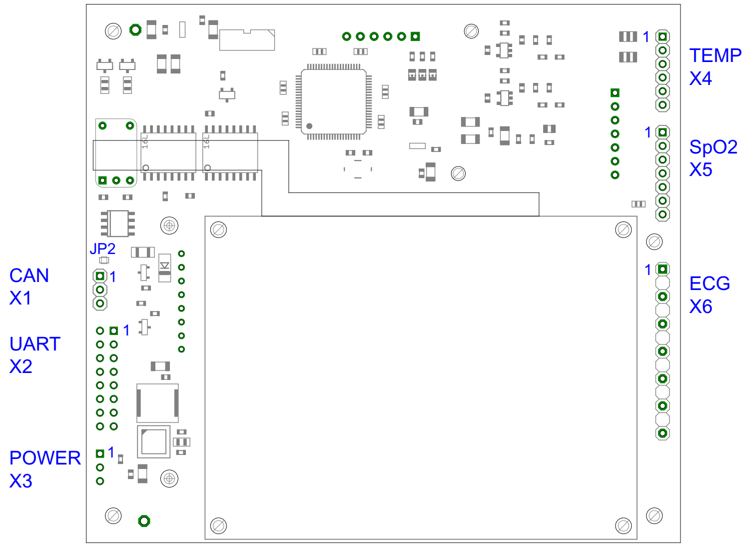


All units in mm.

The test kit version of the board comes with connectors X2-X6 populated, with 90° angled male connectors. The boards for serial production alone are delivered without any connectors populated, in order to enable the user to use the type of connector he needs for his application.

(DXF data of the board is available upon request)

Module Connectors



X1 CAN connector

1	CAN H	CAN bus high line
2	CAN L	CAN bus low line
3	GND	System ground

note: closing JP2 adds a termination resistor to the CAN bus

X2 UART connector

1	GND	System ground
2	GND	System ground
3	TxD CMOS level	Serial data output
4	TxD RS232 level	Serial data output
5	RxD CMOS level	Serial data input
6	RxD RS232 level	Serial data input
7	not connected	
8	ISP	In system programming, used for firmware update
9	GND	System ground
10	GND	System ground
11	R-TRIG	R-wave hardware trigger
12	R-TRIG	R-wave hardware trigger
13	not connected	
14	not connected	
15	not connected	
16	not connected	

X3 Power Connector

1	VCC, 7-15VDC	Power supply of the board
2	Power Down	Connect to GND to power down the complete board
3	GND	System ground

X4 Temperature transducer Connector

1	CH1	YSI400 probe 1
2	IGND	Patient ground
3	CH2	YSI400 probe 2
4	IGND	Patient ground
5	IGND	Patient ground
6	ISet	Enables EEPROM programming when shorted to IGND

Probe1 is connected to IGND and CH1 pin, probe 2 to IGND and CH2 pin. ISet is left open during normal operation.

X5 SPO2 Probe Connector

1	PH1	Photodiode positive input probe pin (DSUB pin 5)
2	PH2	Photodiode negative input probe pin (DSUB pin 9)
3	RSEN	RSEN pin of probe (DSUB pin 1)
4	IGND	Shield of probe cable, Patient ground (DSUB pin 6 and 7)
5	LED1	LED1 pin of probe (DSUB pin 3)
6	LED2	LED2 pin of probe (DSUB pin 2)
7	PDAT	PDAT pin of probe (DSUB pin 4)

The SpO_2 probe has a male Dsub 9 connector. The pin numbering for connecting the probe to the board can be found in the table above. The internal connecting cable between probe and SpO_2 connector should be kept as short as possible.
Depending on the RF immunity level your final product needs to fulfil (3V/m or 20V/m), it might be necessary to include further EMC filtering measures close to the SpO_2 connector input of your medical device. Please contact Medlab for details.

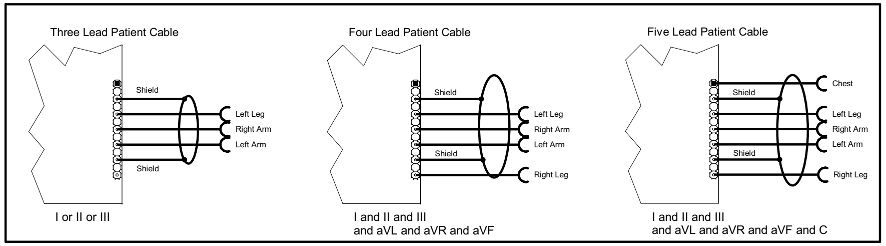
X6 ECG cable Connector

1	C-IN	Chest electrode
2	SHIELD	Patient ground
3	LL-IN	Left Leg electrode
4	RA-IN	Right Arm electrode
5	LA-IN	Left Arm electrode
6	SHIELD	Patient ground
7	RL-IN	Right leg electrode

Patient Cable Connection

ECG cable

The module can be connected to the patient using a three lead, four lead or five lead ECG cable. Depending on cable, one to seven channels of ECG can be measured.



SpO_2 Transducer

The module can work with all Medlab PEARL SpO_2 probes. There are reusable - as well as disposable types. Please see the separate catalog available for the probes. The module cannot work with other manufacturers' SpO_2 probes. The probes have a male DSUB 9 connector, that needs to be connected to the board using an adapter between connector X5 and the probe plug. For prototypes, these adapters are available from Medlab. For series production, as each device requires another length, you should produce your own adapter cables. Also flexible PCBs are a good solution for this adapter.

NIBP Cuffs

While it is not mandatory to use Medlab cuffs for NIBP measurement, best accuracy is reached when using them, as the module's algorithm is developed for the mechanical dimensions of the bladders in the NIBscan cuffs. Also, clinical validation has been done with these cuffs.

Temperature probes

All probes that are compatible with the YSI 400 family resistance specifications can be used. However, the manufacturer of the probe should be selected with care, as the accuracy of the clinical thermometer directly depends on the accuracy of the temperature/resistance curve of the probe.

Specifications

General

Mechanical size:	110 mm x 100 mm 4 layer PCB, thickness 1.6 mm
Maximum height:	33 mm without ECG respiration option, 40 mm with respiration option
Attachment:	four M3 screws in the corners of the PCB
Weight:	175 g
Operating voltage:	7 - 15 V DC
Power consumption:	980 mW while NIBP not measuring (with respiration) 940 mW while NIBP not measuring (without respiration) max. 2000 mW during NIBP pump up max. 1200 mW during NIBP measurement (pump off)

Temperature:	Storage	-30 °C to 90 °C
	Operation	-20 °C to 50 °C
Humidity:	Storage	0 .. 95 %, non condensing
	Operation	5 .. 95 %, non condensing

ECG

Input ECG:	Defibrillation protected
Patient isolation:	4000 Volts RMS
Leakage current:	Better than class CF requirements (<10 µA)
Amplification:	Four stages, user selectable
Data transmission:	Four data output rates, user selectable
Mains filter:	50 Hz, 60 Hz or no notch filter
Other filters:	EMG filter (can be turned on or off)
Amplifier frequency range:	0.05 to 70 Hz
Age modes:	Adult - and neonatal mode
ECG modes:	Diagnostic- and monitoring mode
Lower edge frequency:	0.67 Hz (monitoring) or 0.05 Hz (diagnostic)
Upper edge frequency:	40 Hz (monitoring) or 70 Hz (diagnostic)
QRS detection:	30 .. 247 bpm +- 1%, +- 1 Digit, 12 beat average
Respiration detection:	5 .. 99 rpm +-3%, +- 1 Digit, 8 samples average (option)
Pacemaker:	Pacemaker detector +/-2mV to +/-700mV, 0.5-2ms pulse width, (can also be turned off)
Output:	Separate, adjustable pulse trigger output, (0...5 V level) Trigger output also fully isolated from patient side

SpO_2

Measuring range SpO_2:	0 %..100 % of SpO_2		
Accuracy SpO_2:	90 %..100 %	:	1 % , +/- 1 digit
	80 %..89 %	:	2 % , +/- 1 digit
	70 %..79 %	:	3 % , +/- 1 digit
	70 %..100 %	:	2 % , +/- 1 digit
	below 70 %	:	not specified
Averaging SpO_2:	user selectable in three stages		

Measuring range pulse:	30 .. 249 bpm of pulse rate
Accuracy pulse rate:	+/- 1%, +/- 1 Digit
Averaging pulse rate:	follows SpO_2 averaging

NIBP

Meas. range for adults:	SYS	25 - 280 mmHg
	DIA	10 - 220 mmHg
	MAP	15 - 260 mmHg
Meas. range for neonates:	SYS	20 - 155 mmHg
	DIA	5 - 110 mmHg
	MAP	10 - 130 mmHg
Accuracy, abs. pressure:	+/- 2 mmHg	
Accuracy algorithm:	< +/- 5 mmHg for mean value	
	< 8 mmHg standard deviation	
Pulse rate range:	30 - 230 bpm	
Leakage rate:	< 3 mmHg / minute	
Overpressure limits:	290 mmHg adult mode 150 mmHg neonatal mode	

Temperature

Channels:	2 temperature channels, 1 reference channel (38.8 °C)
Probes:	Compatible with all YSI series 400 probes
Accuracy:	+- 0.1 °C for an ambient Temperature of 10 °C to 40 °C
Measurement range:	25.0 .. 50.0 °C
Warm up time:	less than 30 seconds

Technical description for TRF IEC 60601-2-27:

When preparing a test report form (TRF) for proof of compliance of the users medical product to IEC60601-2-27, the following remarks / technical data will be helpful or needed:

Input Impedance:	> 10 MOhm
Common mode rejection ratio:	> 90 dB at 50 Hz or 60 Hz
Input Dynamic Range:	±5 mV AC, ±300 mV DC
Defibrillator Discharge Recovery:	<10 sec per IEC 601-2-27 <10 sec per AAMI EC13-1992
Leads-off sensing current:	Applied currents less than 150 nA

The following information references particular sections of IEC and EN 60601-2-27:

Respiration (optional) Section 6.8.2.bb.1)
Applied currents less than 80 µA @ 90kHz square

Tall T-wave rejection. Section 6.8.2.bb.2)
T-wave of 1.2 mV amplitude will not affect heart rate determination.

Heart rate averaging. Section 6.8.2.bb.3)
The pulse rate is averaged over the last 12 detected pulses.

QRS Detection (various sections)
If the MP01000 is set to adult mode, the heart rate meter will not respond to ECG signals having a QRS amplitude of 0,15 mV or less, or R-waves of a duration of 10 ms or less, with an amplitude of 1 mV.
The detection range of QRS amplitudes is 0,5 mV to 5 mV, for durations of the QRS complex ranging from 50 ms to 120 ms, up to a signal rate of 300 BPM.
If the MP01000 is set to neonatal mode, the detection range of QRS amplitudes is 0,5 mV to 5 mV, for durations of the QRS wave ranging from 40 ms to 120 ms, up to a signal rate of 350 BPM.

Response to irregular rhythm. Section 6.8.2.bb.4)

A1) Ventricular bigeminy: the MP01000 counts both large and small QRS complexes to display a rate of 80 bpm.

A2) Slow alternating ventricular bigeminy: the MP01000 counts both large and small QRS complexes to display a rate of 60 bpm.

A3) Rapid alternating ventricular bigeminy: the MP01000 counts all QRS complexes to display a rate of 120 bpm.

A4) Bi-directional systoles: the MP01000 counts all QRS complexes to display a rate of 90 bpm.

Heart rate meter response time. Section 6.8.2.bb.5)

a) Change from 80 to 120 BPM: 4 sec

b) Change from 80 to 40 BPM: 7 sec
Time to alarm for tachycardia. Section 6.8.2.bb.6)

Waveform B1:	Amplitude	Time to alarm
	0,5 mV	1 sec
	1 mV	1 sec
	2 mV	1 sec
Waveform B2	Amplitude	time to alarm
	1 mV	1 sec
	2 mV	1 sec
	4 mV	1 sec

Pacemaker pulse display capability (See IEC 601-2-27 clause 50.102.12)

The MP01000 is capable of displaying the ECG signal in the presence of pacemaker pulses with amplitudes of ±2 mV to ±700 mV and durations of 0.5 ms to 2.0 ms. An indication for the pacemaker pulse is provided.

Pacemaker pulse rejection (See IEC 601-2-27 clause 50.102.13)

Without over- and undershoot (rectangular pulse):

a) For single (ventricular-only) pacemaker pulses alone, with 0.1 and 2.0 ms pulse-widths and ±2 mV and ± 700 mV pulse-amplitudes, the MP01000 correctly displays the heart rate as zero bpm (Asystole).

b) For single (ventricular-only) pacemaker pulses with normally paced QRS-T, with 0.1 and 2.0 ms pulse-widths and ±2 mV and ± 700 mV pulse-amplitudes, the MP01000 correctly displays the heart rate of the QRS-T rhythm (60 bpm for the specified test waveform).

c) For single (ventricular-only) pacemaker pulses with ineffectively paced QRS pattern, with 0.1 and 2.0 ms pulse-widths and ±2 mV and ± 700 mV pulse-amplitudes, the MP01000 correctly displays the heart rate of the underlying QRS-T rhythm (30 bpm for the specified waveform).

d) For atrial/ventricular pacemaker pulses alone, with 0.1 and 2.0 ms pulse-widths and ±2 mV and ± 700 mV pulse-amplitudes, the MP01000 correctly displays a heart rate of zero bpm (Asystole).

e) For atrial/ventricular pacemaker pulses with normally paced QRS-T, with 0.1 and 2.0 ms pulse-widths and ±2 mV and ± 700 mV pulse-amplitudes, the MP01000 correctly displays the heart rate of the QRS-T rhythm (60 bpm for the specified test waveform).

f) For atrial/ventricular pacemaker pulses with ineffectively paced QRS pattern, with 0.1 and 2.0 ms pulse-widths and ±2 mV and ± 700 mV pulse-amplitudes, the MP01000 correctly displays the heart rate of the underlying QRS-T rhythm (30 bpm for the specified test waveform).

With over and undershoot:

a) For single (ventricular-only) pacemaker pulses alone, with 0.1 and 2.0 ms pulse-widths and ±2 mV and ± 700 mV pulse-amplitudes, the MP01000 correctly displays a heart rate of zero bpm (Asystole).

b) For single (ventricular-only) pacemaker pulses with normally paced QRS-T, with 0.1 and 2.0 ms pulse-widths and ±2 mV and ± 700 mV pulse-amplitudes, the MP01000 correctly displays the heart rate of the QRS-T rhythm (60 bpm for the specified waveform).

c) For single (ventricular-only) pacemaker pulses with ineffectively paced QRS pattern, with 0.1 and 2.0 ms pulse-widths and ±2 mV and ± 700 mV pulse-amplitudes, the MP01000 correctly displays the heart rate of the underlying QRS-T rhythm (30 bpm for the specified waveform).

d) For atrial/ventricular pacemaker pulses alone, with 0.1 and 2.0 ms pulse-widths and ±2 mV and ± 700 mV pulse-amplitudes, the MP01000 correctly displays a heart rate of zero bpm (Asystole).

e) For atrial/ventricular pacemaker pulses with normally paced QRS-T, with 0.1 and 2.0 ms pulse-widths and ±2 mV and ± 700 mV pulse-amplitudes, the MP01000 correctly displays the heart rate of the QRS-T rhythm (60 bpm for the specified test waveform).

f) For atrial/ventricular pacemaker pulses with ineffectively paced QRS pattern, with 0.1 and 2.0 ms pulse-widths and ±2 mV and ± 700 mV pulse-amplitudes, the MP01000 correctly displays the heart rate of the underlying QRS-T rhythm (30 bpm for the specified test waveform).

Serial Transmission

The host connection to the board is a serial communication interface. By default, transmission is over an asynchronuous, UART style interface, operating at 115200 baud, 8 data bits, no parity bit and one stop bit. Both CMOS and RS232 (+/- 5 Volt level) voltage levels are available on the connector. The RS232 voltage levels are helpful during evaluation of the board, which can be done using an ordinary PC and a special software. The connection in the customer's final system will typically be done through 0V/5V levels, which saves electronic components on the host side of the data stream.

Optionally, the board can also communicate with the host over a CAN interface, at 250k, 500k and 1000k bit transmission rate.

The MP01000 sends data and receives commands. For both CAN and UART mode, the protocol is block oriented.

In UART mode, the block begins with a start sequence, consisting of a start character, a one byte data length counter, and a 16 bit block identifier. This header is followed by a payload block of zero to 8 bytes length. The payload data is followed by a one byte CRC checksum and an end character.
Transmission can be started and stopped with "TXDON" and "TXDOFF" command sent by the host.
In UART mode, the module starts sending data automatically after power up and selftests are finished.

In CAN mode, the content of the payload block is identical to the data blocks in UART mode, but the role of the block identifier mentioned above is actually taken over by the 11 bit CAN identifier. Since the multiparameter board generates a lot of data, priority of the CAN identifiers have to be relatively high (this means low values for identifiers), and consequently, only 11 bit identifiers are supported. Of course, other devices on the CAN bus can use 29 bit identifiers transparently. CRC bytes, start of block and end of block, as well as data length code, are handled automatically by the CAN bus controller of the host.
Transmission can be started and stopped with "TXDON" and "TXDOFF" command sent by the host.
In CAN mode, the module does not start to send automatically after power up. Instead, it waits for the first "TXDON" command, please see description on page ###.

CAN mode is more complicated compared to UART mode, so if your application does not require CAN for technical reasons, we recommend to work using UART mode. The CRC checksum of each block also enables a very reliable and secure data transmission in UART mode.

The neutral line of all waveforms is located at 128 (0x80), since the module transmits unsigned data.

If blocks contain numbers of more than 8 bits length, the lower byte is always transmitted first in the block (little endian).

To set the board to either CAN or UART mode, and to set the CAN speed and the block identifiers, please refer to the chapter "Board setup" of this manual. After delivery, the board defaults to UART mode, base address ECG 0x0100, base address data blocks 0x0200, and base address for command blocks 0x0300.

UART mode block

Header				Data Block (Payload data)	End	
STX (0x02)	Bytecount	Identifier low	Identifier high	Data (1-8 Byte)	CRC8	ETX(0x03)

STX: Start of block character (0x02)
Bytecount: Number of bytes in the data block, plus 0xA0. E.g. 0xA5 is 5 bytes
Identifier: Each type of data block uses another block identifier. Must be <2048, same as Object identifier for CAN
Data: The data to be transmitted, variable length. Command acknowledge or error blocks have a data length of 0
CRC8 checksum of the 4 byte header and the data block. Polynom: x^8+x^5+x^4+x^0
ETX: End of block character (0x03)

CAN mode block

		Data Block (Payload data)
DLC	Object Identifier	Data (1-8 Byte)

DLC: Data length code, number of bytes in the data block. Host reads this from his CAN controller
Object Identifier: CAN bus address, also sets priority of data block. Host reads this from his CAN controller
Data: CAN bus data block. Host reads this from his CAN controller

UART Interface

The host UART has to be initialized for a baud rate of 115200 baud, 8 data bits, no parity bit and one stop bit.
The host has to wait for the STX character, verify that the next byte is a value between 0xA0 (0 byte block length) and 0xA8 (8 bytes block length) and then receive the full data block. After this, the host has to generate the one byte CRC checksum from the STX character to the last data block byte, and compare the result with the received CRC byte. If they have the same value, the block is valid. The host can then decode the received block according to the detailed descriptions of the data block content on the following pages. The polynom used for the CRC generation is x^8 + x^5 + x^4 + x^0. Since the bases addressed in UART mode do not have any special meanings for priorities, as the object identifiers in CAN mode have, it does not make a lot of sense to set them to custom values. It is, however, possible. Transmission of data can be completely turned off by the TXDOFF command, and reenabled by the TXDON command. The board board defaults to TXDON after power up.

CAN Interface

The host CAN controller has to be initialized to 250k, 500k or 1000k bit speed, and the object identifiers described on the next pages have to be added to the acceptance filter of the host's CAN controller.
The host then has to issue a "TXDON" command, and will then start to receive data blocks.
The host has to wait for his CAN controller to signal a successful reception of a CAN block. The host can then decode the received block, according to the detailed descriptions of the data block content on the following pages. The board defaults to TXDOFF after power up.

Object Identifiers (CAN) - Identifier low/high (UART)

Because the object identifiers in CAN mode are directly responsible for the priority of the message on the bus, the basic address of the identifiers can be set by the user in three groups, ECG block base address, host block base address and command block base address. This has been split into three groups, the ECG blocks should have the highest priority (lowest identifier), because the amount of data sent is largest for the ECG wave blocks. The second user adjustable address is the base address for all data blocks to the host, except the ECG blocks, and the third address is the base address used for commands sent to the board by the host.

Serial Transmission Protocol

After the host has received the blocks, either over UART - or CAN interface, the data block descriptions on the next pages can be used for decoding.

ECG Blocks

The board transmits up to 7 ECG waveforms, and an impedance respiration waveform.

The transmitted channels that are available with a five lead cable are:

1) I, Einthoven Lead
2) II, Einthoven Lead
3) III, Einthoven Lead
4) aVR, Goldberger Lead
5) aVL, Goldberger Lead
6) aVF, Goldberger Lead
7) C1, one Wilson lead that should be placed on the chest of the patient
8) Respiration curve

The module works with a three lead-, a four lead- or a five lead cable. Only parts of the maximum number of channels can be measured if not all five electrodes are connected (see page 7).
The board contains a lead-off detection that gives information about each single non-connected electrode.
It is not possible for the module to automatically detect which ECG cable is connected, since the situation is the same whether, for example, a three lead cable or a five lead cable with two non-attached leads is used.
It is recommended for the user to use a connection system with coded cables (shorted, unused pins in the connector for example), to make the host system aware of which cable style currently is connected to the ECG part and to ignore lead-off messages that do not exist for the respective cabling system. The simplest solution is to have the end-user select which cable is connected in a menu entry in the host's user interface.
Channels that are requested by the host but cannot be measured, because of no electrode contact or the respective lead missing in the cable, are transmitted as "0x80", neutral line.

The module features an adult and a neonatal mode.
In adult mode, pulse rates up to 300 bpm are detected. Pulse rates of more than 248 are output as 248 bpm. QRS complexes of 50 ms width and less are not counted as pulses.
In neonatal mode, pulse rates up to 350 bpm are detected and rates of more than 249 are output as 248 bpm. QRS complexes of 50ms down to approximately 20 ms width are counted as pulses.
These differences in adult- and neonatal pulse detection are a requirement of the newest ECG monitoring standard.

The default settings after power up are:
100 wave blocks per second, I,II,III activated, 1cm/mV amplification, monitoring bandwidth, 50 Hz filter active. The host can adjust this to its needs by sending commands to the module.

ECG Blocks

ECGWAVE BLOCK (1 to 8 bytes long) Identifier: **ECGBaseaddress+0x00** (default: 0x100)

Wavesample 1	Wavesample 2	Wavesample 3	Wavesample 4	Wavesample 5	Wavesample 6	Wavesample 7	Wavesample 8

Wavesample 1	Byte 1	8 bit sample value curve 1, in straight binary, neutral line at 0x80
Wavesample 2	Byte 2	8 bit sample value curve 2, in straight binary, neutral line at 0x80
.....	Byte n	note: the amount of curves transmitted depend on the last curve selection command

ECGWAVE blocks are sent 50, 100, 150 or 300 times per second, depending on the last ECG speed command

Power on default is 100 blocks per second

ECGNUM BLOCK (2 bytes long) Identifier: **ECGBaseaddress+0x01** (default: 0x101)

Pulse [1/min]	Resp. rate [1/min]

Pulse [1/min]	Byte 1	8 bit pulse rate value, in bpm, e.g. 1/min
Resp. rate [1/min]	Byte 2	8 bit respiration rate value, in rpm, e.g. 1/min

ECGNUM blocks are sent once after each detected pulse, and can also be used to generate a pulse "beep" on the host

ECGSTAT BLOCK (4 bytes long) Identifier: **ECGBaseaddress+0x02** (default: 0x102)

Electrodes	Channels	Status 1	Status 2

		Bit 7	*Bit 6*	*Bit 5*	*Bit 4*	*Bit 3*	*Bit 2*	*Bit 1*	*Bit 0*
Electrodes	Byte 1	0	resp. wave transmitted	X	Chest lead connected	Right arm connected	Left arm connected	Right leg connected	Left leg connected
Channels	Byte 2	0	C1 transmitted	aVF transmitted	aVL transmitted	aVR transmitted	Einthoven III transmitted	Einthoven II transmitted	Einthoven I transmitted
Status 1	Byte 3	0	N1	N0	EMG filter on	A1	A0	S1	S0
Status 2	Byte 4	0	Neonatal mode	X	X	ST3	ST2	ST1	ST0

ECGSTAT blocks are transmitted once per second

Notch filter *N1..N0*	
00	Notch filter off
01	50 Hz filter on
10	60 Hz filter on
11	reserved

ECG stat *ST3..ST0*	
0000	Normal operation
0001	Normal operation, pacemaker detected
0100	Initializing
0101	Searching for electrodes
1000	Simulated output
1010	Selftest error
....	Rest unused, but reserved

Amp *A1..A0*	
00	Amplification stage 1 (lowest)
01	Amplification stage 2
10	Amplification stage 3
11	Amplification stage 4 (highest)

Speed *S1..S0*	
00	50 wave blocks per second
01	100 wave blocks per second
10	150 wave blocks per second
11	300 wave blocks per second

SpO_2 Blocks

The board transmits the SpO_2 waveform (plethysmogram), a data block, and an Spo_2 status block.

The module works with all Medlab PEARL SpO_2 probes, reusable - and disposable probe types, please see catalog of probes for available types.

After a probe is connected and a finger is detected, the board sends 50 or 100 waveform blocks per second, containing the plethysmographic waveform of the pulse oximeter. Transmission speed of the plethysmogram can be adjusted by sending an "S0" or "S1" command.
The arterial oxygen saturation and the pulse rate are transmitted once per detected pulse, directly after detection took place. The reception of this block can therefore be used to generate a "pulse beep" on the host. Also the status block is transmitted once per detected pulse, directly after the data block.

The perfusion index in the status block gives an indication for the perfusion at the measurement site. The table on the next page explains the meaning of the different stages of perfusion. This is important, because the plethysmogram is automatically scaled. Therefore, the height of the plethsymogram is not a direct indication for the perfusion at measurement site.

If no finger is in the probe or no probe is connected, the waveform transmitted is a flat line. The value package and the status package are in this case transmitted once per second. Oxygen saturation and pulse rate are set to zero, and the info byte contains either the "No sensor" or "No signal" info.

Medlab GmbH MP01000 User Manual

SpO2 Blocks

SPO2WAVE BLOCK (1 byte long)

Plethys-mogram

Plethys-mogram	Byte 1	8 bit sample value plethysmographic waveform, in straight binary, neutral line at 0x80

SPO2WAVE blocks are transmitted 100 times per second

SPO2NUM BLOCK (2 bytes long)

SpO2 [%]	Pulse [1/min]

SpO2 [%]	Byte 1	8 bit SpO2 value, in %
Pulse [1/min]	Byte 2	8 bit pulse rate value, in bpm, e.g. 1/min

SPO2NUM blocks are sent once after each detected pulse, and can also be used to generate a pulse "beep" on the host

SPO2STAT BLOCK (3 bytes long)

Status	Quality	Perfusion

		Bit 7	*Bit 6*	*Bit 5*	*Bit 4*	*Bit 3*	*Bit 2*	*Bit 1*	*Bit 0*
Status	Byte 1	0	S6	S5	S4	S3	S2	S1	S0
Quality	Byte 2	0	0	0	0	Q3	Q2	Q1	Q0
Perfusion	Byte 3	0	0	0	0	0	P2	P1	P0

SPO2STAT blocks are sent once after each detected pulse

Status *S6..S0*		
0000000	0x00	OK
0000001	0x01	No probe detected
0000010	0x02	No finger in probe
0000011	0x03	Low perfusion
1000101	0x45	Selftest error

Quality *Q3..Q0*	
	Quality is a number between 0 and 10, coded into the lower four bits of status byte 2. If the number is 0, ten or more consecutive pulses have been detected without artefact or other problems. Zero therefore means best quality.

Perfusion *P2..P0*		
000	unused	
001	< 0.25%	AC/DC ratio
010	0..25-0.5%	AC/DC ratio
011	0.5-1.0%	AC/DC ratio
100	1.0-2.0%	AC/DC ratio
101	2.0-4.0%	AC/DC ratio
110	4.0-8.0%	AC/DC ratio
111	> 8.0%	AC/DC ratio

NIBP Blocks

Measurements of NIBP must be individually started by sending the relevant command to the NIBP board. Alternatively, the board can be set to "cycle" mode. Then, a measurement is automatically started after the selected time frame has passed.
For measurements on neonates, the board must be set to "neonatal mode". For adults, children and infants, the board should be set to "adult mode".
During measurement, the current cuff pressure is transmitted five times per second, and can be used to indicate cuff pressure to the user with a bargraph or a similar indicator on the user interface of the device.
During measurement, a "break command" immediately stops measurement and deflates the cuff. Directly after a measurement has ended, a NIBPNUM block is transmitted, together with a status block. If errors have been detected during measurement, the pressure values and pulse rate in the NIBPNUM block are set to zero. NIBPNUM and status blocks are then repeated every ten seconds. Also sent every ten seconds is a NIBPTIMERBLOCK. This block indicates how old the values in the NIBPNUMBLOCK are. It is a common feature of monitors to blank out measurements that are older than a certain amount of time, not to mislead the user about the current NIBP values of the patient, that might be already totally different. The second value in the timer block indicates the time until the next measurement is automatically started, when in cycle mode.

NIBP Blocks

NIBPCURRENTCUFFPRESSURE BLOCK (2 bytes long)

Pressure low byte	Pressure high byte

Pressure low byte	Byte 1	16 bit value of current pressure in NIBP cuff, in mmHg, low byte part
Pressure high byte	Byte 2	16 bit value of current pressure in NIBP cuff, in mmHg, high byte part

NIBPCURRENTCUFFPRESSURE BLOCKS are only transmitted during ongoing measurements, 5 times per second

NIBPNUM BLOCK (7 bytes long)

Sys low	Sys high	MAP low	MAP high	Dia low	Dia high	Pulse rate

Sys low	Byte 1	16 bit value of measured systolic pressure, in mmHg, low byte
Sys high	Byte 2	16 bit value of measured systolic pressure, in mmHg, high byte
MAP low	Byte 3	16 bit value of measured mean arterial pressure, in mmHg, low byte
MAP high	Byte 4	16 bit value of measured mean arterial pressure, in mmHg, high byte
Dia low	Byte 5	16 bit value of measured diastolic pressure, in mmHg, low byte
Dia high	Byte 6	16 bit value of measured diastolic pressure, in mmHg, high byte
Pulse rate	Byte 7	8 bit value of measured pulse rate, in bpm (1/min)

NIBPNUM BLOCKS are transmitted after each measurement, and then every ten seconds

NIBPTIMER BLOCK (4 bytes long)

Time meas. low	Time meas. high	Time to cycle low	Time to cycle high

Time since meas. low	Byte 1	16 bit value, time passed since last measurement, in seconds, low byte
Time since meas. high	Byte 2	16 bit value, time passed since last measurement, in seconds, high byte
Time to cycle low	Byte 3	16 bit value, time until next measurement, in seconds, low byte (0 if no cycle mode active)
Time to cycle high	Byte 4	16 bit value, time until next measurement, in seconds, high byte (0 if no cycle mode ac

NIBPTIMER BLOCKS are transmitted after each measurement, and then every ten seconds

NIBPSTAT BLOCK (4 bytes long)

State	Adult/Neo	Cycle	Error

		Bit 7	*Bit 6*	*Bit 5*	*Bit 4*	*Bit 3*	*Bit 2*	*Bit 1*	*Bit 0*
State	Byte 1	0	0	0	0	0	S2	S1	S0
Adult/Neo	Byte 2	0	0	0	0	0	0	0	A0
Cycle	Byte 3	0	C6	C5	C4	C3	C2	C1	C0
Error	Byte 4	0	0	0	0	E3	E2	E1	E0

NIBPSTAT BLOCKS are transmitted after each measurement, and then every ten seconds

State	
S2..S0	
000	Auto test in progress (only during boot)
001	Wait for command, no cycle mode
010	Error, see bits E3..E0 for details
011	Measuring in progress
100	Manometer mode
101	Initializing
110	Reserved
111	Leakage test in progress

Adult/Neo	
A0	
0	Adult mode
1	Neonatal mode

Cycle		
C6..C0		
0000000	0x00 (0)	No cycle selected
0000001	0x01 (1)	1 minute cycles selected
0000010	0x02 (2)	2 minutes cycles selected
0000011	0x03 (3)	3 minutes cycles selected
0000100	0x04 (4)	4 minutes cycles selected
0000101	0x05 (5)	5 minutes cycles selected
0001010	0x0A (10)	10 minutes cycles selected
0001111	0x0F (15)	15 minutes cycles selected
0011110	0x1E (15)	30 minutes cycles selected
0111100	0x3C (60)	60 minutes cycles selected
1011010	0x5A (90)	90 minutes cycles selected

Error		
E3..E0		
0000	0x00	No error
0001	0x01	Reserved
0010	0x02	Autotest failed
0011	0x03	No error
0100	0x04	Reserved
0101	0x05	Reserved
0110	0x06	Cuff fitted too loosely or not connected
0111	0x07	Leakage (including sudden occurance)
1000	0x08	Faulty slow loss of pressure
1001	0x09	No pulse detected (cuff incorrectly fitted)
1010	0x0A	Measurement range exceeded
1011	0x0B	Movement artefacts too strong
1100	0x0C	Excess pressure (according to IEC limits)
1101	0x0D	Pulse signal too large
1110	0x0E	Leakage during leakage test
1111	0x0F	System error

Temperature Blocks

The MP01000 can be connected to up to two probes of the YSI400 temperature probe series, to measure up to two body temperatures.
Measurement range is 20.0-45.0 °C. Outside this temperature window, the respective channel will report a "too low" or "too high" error in the status block. Also an open input is indicated in the status block. The board has a status channel, that always should read as 38.8°C.
Each board is individually calibrated, and the calibration constants are stored in two copies in an EEPROM on the board. If CRC check of both copies fails, a calibration lost error is given in the status block. This error is fatal, the board has to be resent for recalibration.
Temperature and status blocks are sent once per second, by default. Using a command, this rate can be increased to five blocks per second.

Temperature Blocks

TEMPNUM BLOCK (6 bytes long)

Temperature 1 low	Temperature 1 high	Temperature 2 low	Temperature 2 high	Temperature ref. Low	Temperature ref. High

Temperature 1 low	Byte 1	16 bit value of measured temperature channel 1, in °C * 10, low byte
Temperature 1 high	Byte 2	16 bit value of measured temperature channel 1, in °C * 10, high byte
Temperature 2 low	Byte 3	16 bit value of measured temperature channel 2, in °C * 10, low byte
Temperature 2 high	Byte 4	16 bit value of measured temperature channel 2, in °C * 10, high byte
Temperature ref. Low	Byte 5	16 bit value of measured temperature in reference channel , in °C * 10, low byte
Temperature ref. High	Byte 6	16 bit value of measured temperature in reference channel , in °C * 10, high byte

TEMPNUM blocks are sent once per second or five times per second, depending on the last temperature "speed" command

Power on default is 1 block per second

TEMPSTAT BLOCK (3 bytes long)

Status channel 1	Status channel 2	Status channel ref

Status channel 1	Byte 1	8 bit value status channel 1,
Status channel 2	Byte 2	8 bit value status channel 2
Status channel ref	Byte 3	8 bit value status reference channel

TEMPSTAT blocks are sent once per second

Status		
0000000	0x00	OK
0000001	0x01	No probe detected
0000010	0x02	Temperature too low
0000011	0x03	Temperature too high
0000100	0x04	Calibration lost

Status Blocks

The MP01000 has a few blocks that are not related to a parameter, but rather refer to the module in general (general blocks). They are only transmitted after they have been requested by the user. They include individual serial number of the board, status of the board and firmware versions of the different subsystems. For details, please see the following page.

General Blocks

GENERALSTAT BLOCK (6 bytes long)

Internal 1	Internal 2	Internal 3	Internal 4	Host overrun error counter	Command error counter

Internal 1	Byte 1	8 bit value, internal use only
Internal 2	Byte 2	8 bit value, internal use only
Internal 3	Byte 3	8 bit value, internal use only
Internal 4	Byte 4	8 bit value, internal use only
Host overrun error counter	Byte 5	8 bit value, command lost, host sent two consecutive commands to fast
Command error counter	Byte 6	8 bit value, counts unknown commands, frame - and crc errors during reception

GENERALSTAT blocks are sent once only after an "MPS" command has been sent by the host

VERSION BLOCK (4 bytes long)

Board version	ECG version	NIBP Version	SPO2 Version

Board version	Byte 1	8 bit value, version of multiparameter board firmware
ECG version	Byte 2	8 bit value, version of ECG firmware
NIBP Version	Byte 3	8 bit value, version of NIBP firmware
SPO2 Version	Byte 4	8 bit value, version of SpO2 firmware

VERSION blocks are sent once only after an "MPV" command has been sent by the host

SERNUM BLOCK (4 bytes long)

Byte 1	Byte 2	Byte 3	Byte 4

Byte 1	Byte 1	32 bit value, serial number, lowest byte
Byte 2	Byte 2	32 bit value, serial number, byte 2
Byte 3	Byte 3	32 bit value, serial number, byte 3
Byte 4	Byte 4	32 bit value, serial number, highest byte

SERNUM blocks are sent once only after an "MPN" command has been sent by the host

Command Blocks

The module can receive several commands that, after successful reception and decoding, are then executed by the module. All commands are standard communication blocks with a data block length of three bytes. The commands are acknowledged by the board with a standard block of data length 0.

On the following pages, the data blocks of the commands are described in more detail.

After the board receives the command block, it checks the following:

1) All bytes of the command block arrived within a timeout period of 5ms -> no -> timeout error
2) Requirements of the general structure of the command block fulfilled -> no -> frame error
3) Byte counter of the data block set to three bytes -> no -> frame error
4) CRC of the data block correct* -> no -> CRC error
5) Are the three bytes of the data block a valid command -> no -> unknown command error

* this can be checked for UART mode only, in CAN mode, blocks that do have false CRC's are suppressed by the CAN controller of the board. The host CAN controller resends the command block in case of CRC errors.

If all requirements are fulfilled, the board answers with an "ACK" block (see below for description). In all other cases, a specific error block, as described above, is sent back to the host.

Example:
The host wants to set the ECG speed to 300 samples per second. Block identifiers have their default value:

Host sends command frame: 0x02 0xA3 0x00 0x03 0x45 0x53 0x37 0xEC 0x03
Board returns an "ACK" frame: 0x02 0xA0 0x40 0x02 0xD6 0x03
Board changes ECG setting

Command Block (Host -> MP01000)

Header				Data Block			End	
STX (0x02)	Bytecount	Address low	Address high	Data (3Byte)			CRC8	ETX(0x03)

Bytecount = 0x03 + Bytecountmodifier (0xA0)

x^8+x^5+x^4+x^0

ECG	command address + 0	Default command address: 0x300
SPO2	command address + 1	
NIBP	command address + 2	
TEMP	command address + 3	
MULTIPAR	command address + 4	
TXONOFF	command address + 5	

Command Acknowledge Blocks (MP01000 -> Host)

Header				End	
STX (0x02)	Bytecount	Address low	Address high	CRC8	ETX(0x03)

Bytecount = 0x0 + Bytecountmodifier (0xA0)

ACK	block address + 0x40	Default block address: 0x200
ERRFRAME	block address + 0x41	
ERRTOUT	blockaddress + 0x42	
ERRCRC	blockaddress + 0x43	
ERRCOM	blockaddress + 0x44	

Note: for acknowledge blocks, data block is always of length zero

ECG commands

All commands have a three byte structure. First byte is always „E“, the second byte and third byte are described below.

Basic Bandwidth of ECG amplifier (Diagnostic or Monitoring mode):
„F0“ bandwidth of the amplifier DC-80 Hz Diagnostic mode (bear in mind mains filter setting)
„F1“ bandwidth of the amplifier 0.67-40 Hz Monitoring mode (reset value)

Transmission frequency of the waveform packet:
„S0“ send waveform packets 50 times per second
„S1“ send waveform packets 100 times per second (reset value)
„S2“ send waveform packets 150 times per second
„S7“ send waveform packets 300 times per second

Amplification of the waveforms
„A0“ Amplification stage 1 (lowest amplification, should be scaled to 0.5 cm/mV)
„A1“ Amplification stage 2 (reset value)
„A2“ Amplification stage 3
„A3“ Amplification stage 4 (highest amplification, should be scaled to 4 cm/mV)
Each amplification stage has **double the sensitivity** of the previous stage

Channel selection (1-8 wave channels can be selected)
„Cx“ Each bit in byte 'x' set to „1“ stands for a transmitted wave, a „0“ means that wave is not transmitted.
10000000 respiration
01000000 C1
00100000 aVF
00010000 aVL
00001000 aVR
00000100 III
00000010 II
00000001 I
Example: to receive I, aVR and respiration, send: 0x45 (character ‚E‘), 0x43 (character ‚C‘), 0x89

Filtering of the waveforms for 50 and 60 Hz line frequency:
„50“ 50 Hz and 60 Hz Filter off
„51“ 50 Hz Filter on (reset value)
„52“ 60 Hz Filter on

Filtering of the waveforms for EMG interference (~15-30 Hz):
„E0“ EMG Filter off (reset value)
„E1“ EMG Filter on

Set board to adult mode or neonate/pediatric mode: [1]

"N0" board is in adult mode (reset value)

"N1" board is in pediatric/neonate mode

Calibration mode (1mV rectangle transmitted for 250 samples):

„K0“ output 250 samples of 1mV rectangular waves, then go back to normal mode

Update electrode configuration. Recognizes newly connected electrodes

„q0“ Newly connected electrodes are recognized after this command has been sent to the module. Also any other command except "K" and "I" starts a new search for connected electrodes.

Simulated data outputs (useful for testing or exhibitions):

„M0“ use real input for data transmission (reset value)

„M1“ use simulated output waves and values

Pacemaker detection on or off:

„P0“ do not detect pacemaker pulses

„P1“ detect pacemaker pulses (reset value)

Set delay of the pulse trigger signal (active high, 33ms duration):

„T0“ Delay of the pulse trigger signal 15ms (reset value)

„T1“ Delay of the pulse trigger signal 50ms

„T2“ Delay of the pulse trigger signal 100ms

„T9“ The signal triggers in the middle between R waves

SpO_2 Commands

All commands have a three byte structure. First byte is always „S“, the second byte and third byte are described below

Transmission speed of plethysmogram:

„S0“ send 50 waveform blocks per second

„S1“ send 100 waveform blocks per second (reset value)

Averaging of the SpO_2 value:

„A0“ low averaging, e.g. fast SpO_2 reaction

„A1“ medium avaraging of SpO_2 (reset value)

„A2“ strong averaging of SpO_2 value

NIBP Commands

All commands have a three byte structure. First byte is always „N“, the second byte and the third byte are described below

Start a new measurement

„S1“

Stop an active measurement cycle immediately

„XX“

Adjust automatic cycle mode:

„C0“ cycle mode off (reset value)

„C1“ cycle mode 1 minute

„C2“ cycle mode 2 minutes

„C3“ cycle mode 3 minutes

„C4“ cycle mode 4 minutes

„C5“ cycle mode 5 minutes

„C6“ cycle mode 10 minutes

„C7“ cycle mode 15 minutes

„C8“ cycle mode 30 minutes

„C9“ cycle mode 60 minutes

Note: the module must be started with a "S1" command and perform one successful measurement to actually enter cycle mode thereafter.

Set start pumpup pressure

„P0“ set start pumpup pressure 100 (only neonatal mode)

„P1“ set start pumpup pressure 120 (only neonatal mode)

„P2“ set start pumpup pressure 140 (reset value)

„P3“ set start pumpup pressure 160 (only adult mode)

„P4“ set start pumpup pressure 180 (only adult mode)

Set mode

„N0“ set adult mode (reset value)

„N1“ set neonatal mode

Start manometer mode

„M1“ start manomater mode

Start leakage test

„L1“ start leakage test

Temperature Commands

All commands have a three byte structure. First byte is always „T“, the second byte and the third byte are described below

Set transmission speed

„S0“ send one data block per second (reset value)

„S1“ send five data blocks per second

Multiparameter Commands

All commands have a three byte structure. First byte is always „M“, the second byte and the third byte are described below.

Serial number

„PN“ the MP01000 returns a 32bit serial number in a 4 byte data block. See page 25.

Status

„PS“ the MP01000 returns board status in a 5 byte data block. See page 25.

Note: the error counters are reset after transmission of the status block

Version number

„PV“ the MP01000 returns firmware version number info in a 4 byte data block. See page 25.

Transmission on/off

„T0“	serial data transmission off	(reset value for CAN interface mode)
„T1“	serial data transmission on	(reset value for UART interface mode)

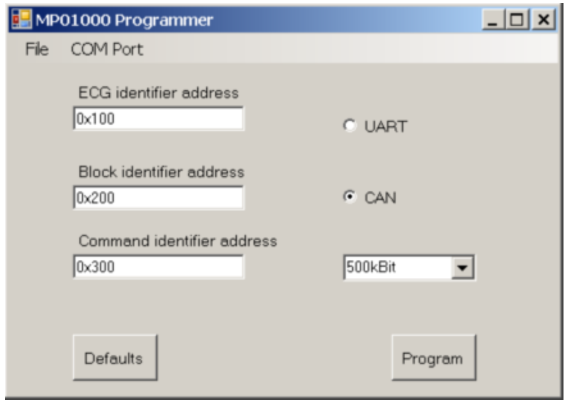
Board Setup

The board can store several user settings in its on-board EEPROM.

These are programmed into the MP01000 using a special software provided by Medlab. This program does not need installation, just copy it to a directory of your choice and run it. It requires MS.NET 2.0.

Connection to the MP01000 for setting these parameters is always done over the UART interface, also if currently the main board communication is set to CAN interface.
In order to enter this mode, power down the board, and connect pin 5 and pin 6 of connector X4 (see page 6) with a jumper. If you now power on the board, you are able to program the following settings:

UART mode or CAN mode (UART mode is default on delivery)
Bit rate of the CAN mode (250 kBit, 500 kBit or 1000 kBit), ignored in UART mode
Block identifier for ECG data blocks to the host (default 0x100)
Block identifier for other data blocks to the host (default 0x200)
Block identifier for command blocks to the board (default 0x300)



Please note that programming is only possible if pin 5 and pin 6 of X4 are shorted during power up. This is mainly to avoid unintended reprogramming of the parameters during normal operation.

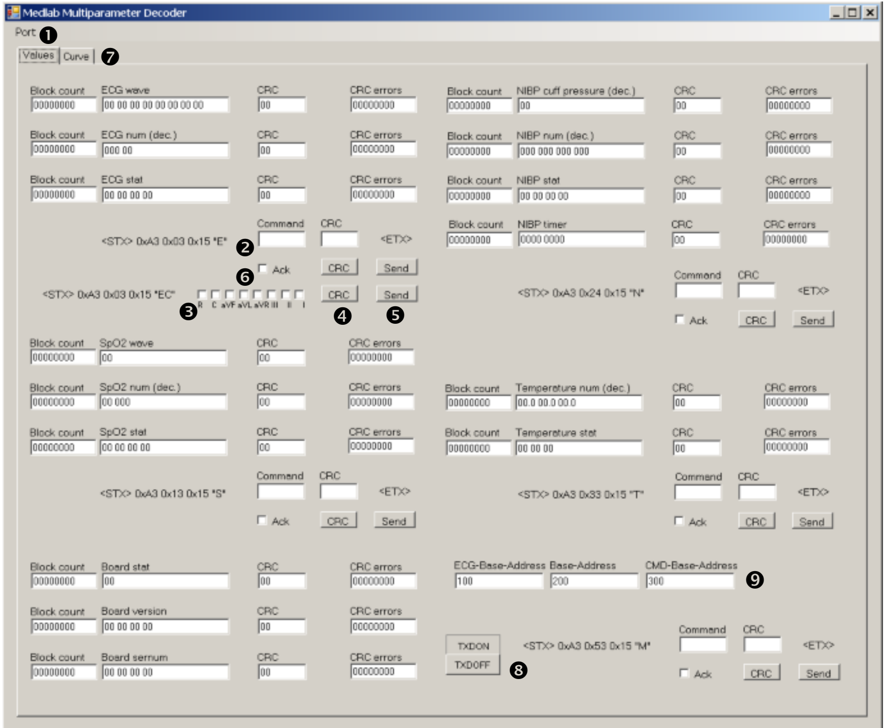
Default button sets the form entries to the delivery values of the MP01000. One must press the program button afterwards to reprogram these settings into the board's EEPROM memory, though.

If you are using the UART mode to interface to the board, there is no reason to use this tool: the block identifier addresses in UART mode do not have an additional influence, as they have in CAN mode, where they are directly responsible for the priority of the respective message.

Test Program

A Microsoft Windows program (Multiparam.exe) is available for getting used to operate the board. The program does not need installation, just copy it to a directory of your choice and run it. It requires MS.NET 2.0.

The software allows to see all received data blocks and waveforms. It is also possible to send commands within this program.



- Select the COM port the MP01000 is connected to ❶. You should now already see data coming in.

- Try sending an ECG command, by either entering one of the commands described on page 27 into field ❷, or by selecting several of the ECG traces you want to receive in the tick boxes ❸.

- Press the CRC button ❹ to generate the CRC for the command, and press the send button ❺. If the command is recognized, an "ACK" block is returned, and the tick box is activated ❻. Other commands are sent in the same way, in the respective data fields of the different parameters.

- Select the "CURVE" tab ❼ to see the ECG and SpO2 waveforms

- Communication can be turned on and off with the buttons next to ❽

- The object identifiers the program listens to can be set here ❾. This must match the board settings, or no data blocks will be received any more. Shown is the standard setting.

Regulatory Considerations

The device that has been described in this document is not a final medical product. This means that it cannot be used as a standalone unit to use it on patients.
Therefore, the MP01000 has not been - and also cannot be - CE-marked. The customer has to undertake the procedure of CE-marking with the final product that contains the module.
CE-marking a multiparameter device is a serious task that is complicated and needs time and money. The MP01000 helps the customer to develop a product that conforms to the standards in a faster way.
However, it is up to the customer to test the final product to prove to the authorities and notified body that his product is in conformance with all the requirements.

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V0.96:	03.12.2013	corrected typos
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