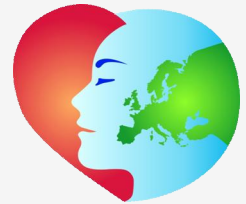


-90 -80 -70 -60 -50 -40 -30 -20 -10

-10

-20

# HealthLab-Satellite SAT-21



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## 1 General Remarks

The HealthLab measuring satellite SAT-21 is a measurement module of the psycho-physiological monitoring system HealthLab. As part of measurements with HealthLab, the satellite SAT-21 records temperature values, heart rate and activity of the cardiac muscle by using ECG, as well as the respiration of a proband. The device transmits the captured data to a HealthLab Master, where they will be stored and transferred to a host computer (Windows), which is provided as monitoring and evaluation-system.

A maximum of 26 satellites are able to communicate with the Master via a serial bus (HealthLab Serial Slave Bus). An unique address (1 ... 26) is assigned to each satellite. This slave address is factory set and can be modified by manufacturer if necessary.

## 2 Operating Principle

The HealthLab measuring satellites detect the measuring signals by integrated or attached sensors. The measurement data is displayed, exported and analysed using the software HealthLab ('Heally Control', 'Heally', 'HlabExport', 'HLEplorer'). The satellite SAT-21 measures the signals described below.

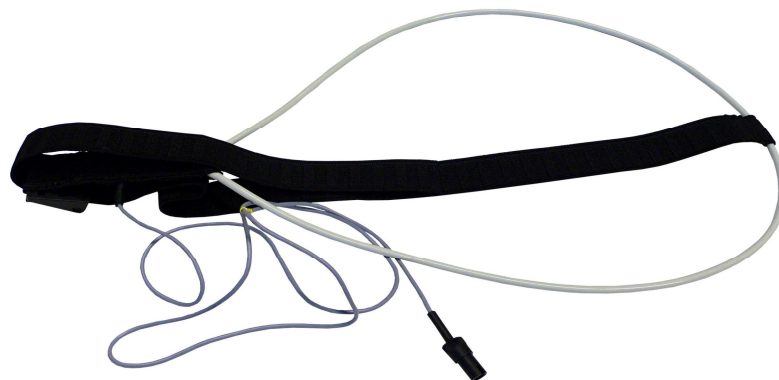
### 2.1 Electrocardiogram

The Electrocardiogram is designed as one-channel ECG ( *chest lead* ).



### 2.2 Respiration

Measurement data on the activity of the lungs are captured by the SAT-21 using the strain gauge strip of a respiration strap (pictured below) or a breath sensor that reacts to temperature changes within the airflow below the nose.





## 2.3 Temperature Measurement

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The measuring satellite SAT-21 measures temperature values using up to four NTC temperature sensors or two double temperature sensors. When using the patented temperature dual sensors Dräger (*forehead or sternum sensor - pictured left*) the device calculates the core body temperature of the proband. Each sensor provides three temperature values. Each double sensor measures the temperature on the skin surface of the proband, and the temperature at a defined distance to the skin surface using the second sensor. The calculation of the core temperature is carried out using a special heat flow equation, developed by the Dräger Company.

## 3 Putting into Operation

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For putting into operation, each HealthLab measuring satellite is to connect to the respective sensor technology, which is provided for the current planned measurements. Similarly the device is to connect with eventually in addition used satellites and the HealthLab-Master. Thereby, the correct cabling is to be observed.

The sensors used are to be placed in accordance to their intended use.

The PC software Heally Control (HL5\_Heally.exe) allows to select the channels to be measured, and to configure their parameters, such as sample rate, gain, filters, etc..

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-30 -20 -10

10 20 30 40 50 60 70 80 90

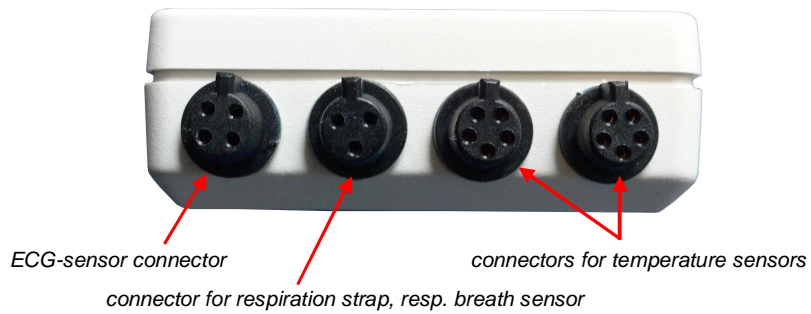


### 3.1 Connectors

The SAT-21 provides the following connectors:

#### 3.1.1 Respiration, ECG- and Temperature Sensors

At the lower end face of the measuring satellite SAT-21 are the connectors for the respiration strap (alternatively breath sensor) and for the ECG- and temperature sensors.



#### 3.1.2 Master and Measuring-Satellites



The connection of the device with the HealthLab-Master and with additional measuring satellites is done using the connection cables (pictured left) type VMS-10 and VSS-05, which are available as accessories. Socket and plug on the satellite (pictured above) are connected in parallel. They are used for connection to the above described serial slave bus, resp. for the forwarding of the slave bus. A number of slaves may be connected to the bus, but only one master is allowed to be connected. An unique address (slave-address, address-range 1 up to 26) is assigned to each connected slave.



Note: the bus also provides the power supply to the entire system. The required batteries or accumulators are part of the respectively used master. Look up for details in the separate description for the respective HealthLab Master.



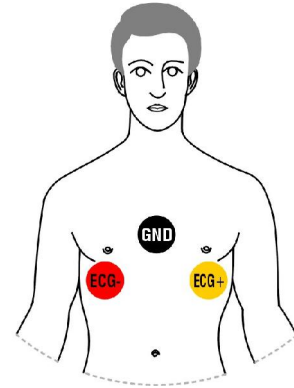
### 3.2 Preparation of the Proband

The sensors of a HealthLab measuring satellite, which are respectively provided for use, are to be placed at the proband in accordance to their intended use. With the SAT-21 the using of an ECG sensor, a respiration strap or breath sensor, as well as up to four temperature sensors is possible.

#### 3.2.1 ECG Sensors

The ECG sensor lead is to be connected to the socket of the SAT-21, which is assigned to this purpose (see chap. 3.1 Connectors).

Before applying the ECG electrodes, the relevant parts of the skin have to be cleaned thoroughly with isopropyl alcohol. Then, first the electrode cables are clicked onto the adhesive electrodes. Thereafter deduct the protective foils from the electrodes and affix them at the provided positions (see figure right) on the cleaned parts of the skin.



#### 3.2.2 Respiration Strap

The breath sensor is to be connected to the socket of the SAT-21, which is assigned to this purpose (see chap. 3.1 Connectors). The placement of the sensors is carried out differently according to the respectively used sensor.

The respiration strap is to be applied around the chest. Using its tensioning and closure unit it is to set in pre-tension, as far as is necessary to avoid its slipping. Depending on the measurement project, the focus of measuring can be set either on chest- or on abdominal breathing, by positioning of the respiration strap.

The breath sensor is equipped with two thermistors to capture the breathing below of nose, and a third one as temperature reference. It is applied to an adhesive strip. First it is to connect to the sensor cable. Thereafter, the adhesive strip is released from the carrier sheet, and transversely affixed below the nose.

Hereby, the two breath sensors are to be positioned under the nostrils, while the tongue with the reference sensor is pointing towards chin. At proper attachment, the ends of the adhesive strip reach the cheek areas of the proband.

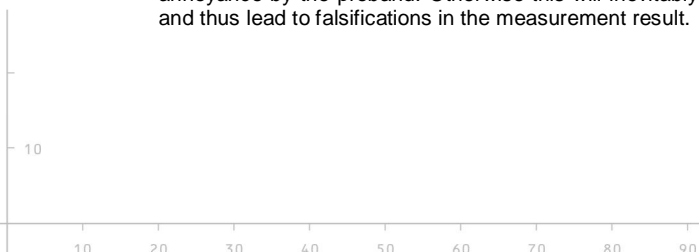
#### 3.2.3 Temperature Sensors

Depending on the respective intended measurement, different temperature sensors are used. The respective sensor cable is connected to one of the two sockets, provided for this purpose with the measuring satellite SAT-21 (see chap. 3.1 Connectors).

The sensors are to be applicated according to their intended use. Thus, for example skin temperature sensors with adhesive tape are affixed to the skin surface according to the specification of the measurement project. The double temperature sensors, which are developed by company Drägerwerk AG, are to be used in accordance to its experimental directives (see details there).



**Note:** To avoid the falsification of measurement data, the influence of the use of an measuring instrument to the recorded data must be basically prevented. Therefore it is necessarily to observe, that positioning and fixing of the sensors will not be regarded as an annoyance by the proband. Otherwise this will inevitably lead to a change in his behaviour and thus lead to falsifications in the measurement result.





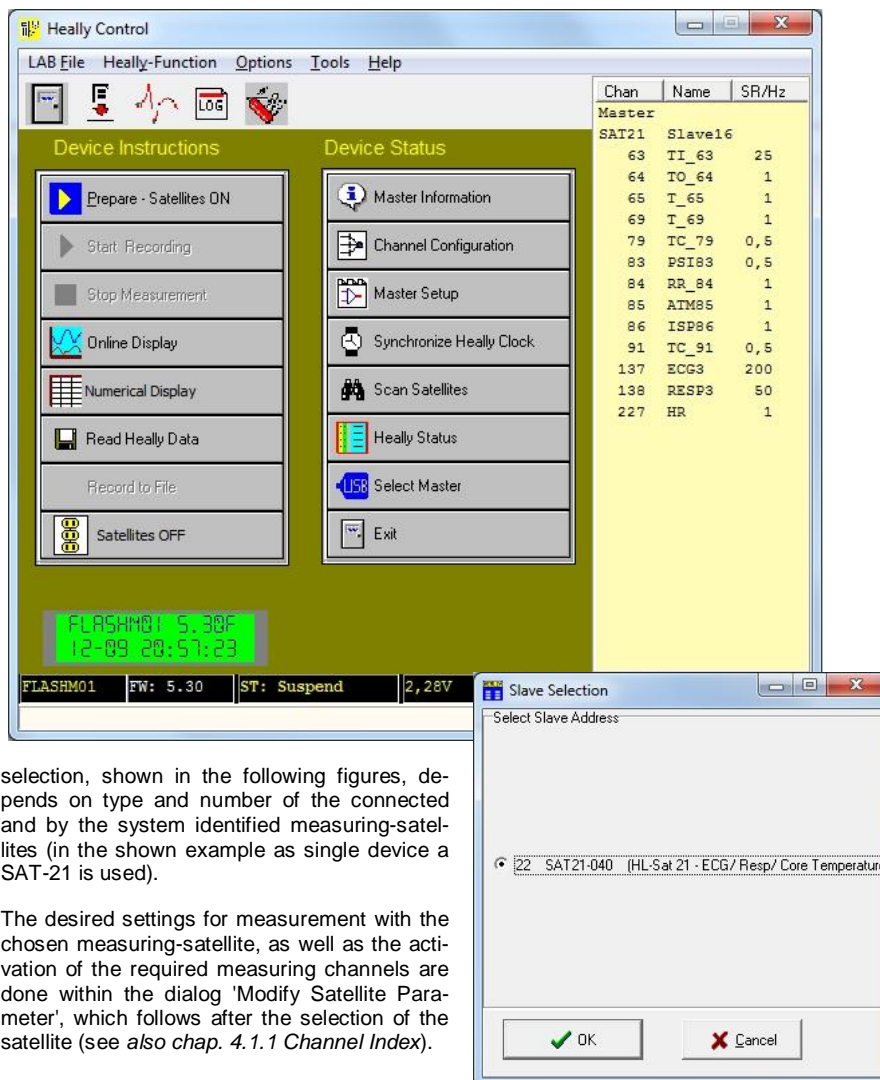
## 4 Measurement

After the SAT-21 is connected to a switched off master, resp. to other measuring satellites with connection to the master, the device will be supplied with power on activation done by the master and goes in operation with starting of measurement. Look up for details in the separate description for the respective HealthLab Master.

Using the software 'Heally Control' (HL5\_Heally.exe) the relevant settings for measurements will be done and transmitted to the respective measuring-satellite. The HealthLab software transmits all data, captured and recorded by the monitoring system HealthLab, to the PC system which is provided as monitoring and evaluation-system. Even the analysis of measurement data is done by the software. Look up for details in the separate description for the HealthLab software.

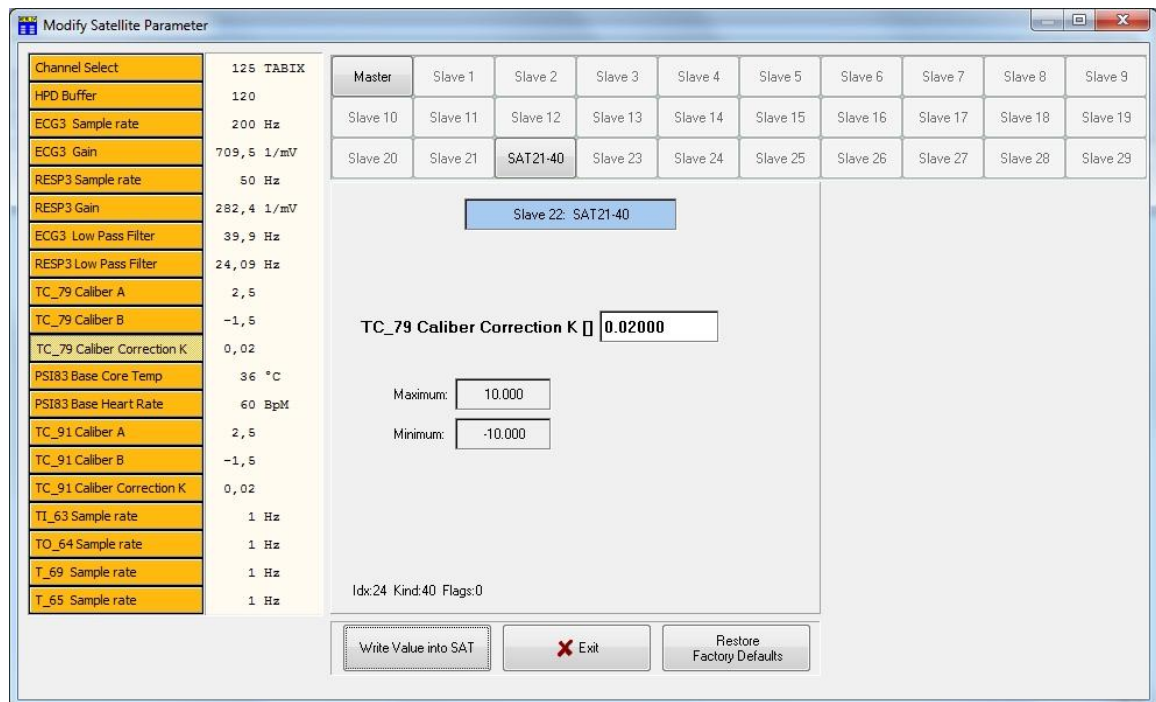
### 4.1 Preparation / Configuration

Within the control program 'Heally Control' the configuration of the measuring-satellite is called up by actuating (clicking) the button 'Channel Configuration' (see fig. below). The



selection, shown in the following figures, depends on type and number of the connected and by the system identified measuring-satellites (in the shown example as single device a SAT-21 is used).

The desired settings for measurement with the chosen measuring-satellite, as well as the activation of the required measuring channels are done within the dialog 'Modify Satellite Parameter', which follows after the selection of the satellite (see also chap. 4.1.1 Channel Index).



The selection of the device, which currently is to be configured, is done via the block in the upper range of the input-dialog, in which the applied satellites are displayed in form of buttons (*shown here: SAT21-40*). After actuating of one of this buttons, the selection is highlighted in blue displayed in central range of the dialog box (*shown here: Slave 22: SAT21-40*) and the adjustable parameters of the satellite can be selected by orange buttons in the left part. With the Satellite SAT-21 the following parameters are available ('TC\_79 Caliber Correction K' is chosen in figure above):

- Channel Select: activation / deactivation of the required measuring channels
- HPD Buffer: number of heart rate values, which are used for the continuous calculation of mean value and RMSSD;
- ECG3 Sample Rate: sample rate of the ECG sensor;
- ECG3 Gain: amplification of the ECG signal;
- RESP3 Sample Rate: sample rate of the breath sensor;
- RESP3 Gain: amplification of the breath sensor's signal;
- ECG3 Low Pass Filter: low pass filter for ECG;
- RESP3 Low Pass Filter: low pass filter for breath sensor;
- TC\_79 Caliber A: calibration coefficient A for double sensor sternum;
- TC\_79 Caliber B: calibration coefficient B for double sensor sternum;
- TC\_79 Caliber Correction K: correction value K for double sensor sternum;
- PSI83 Base Core Temp: body core temperature - base for calculation of PSI (*stress index equals 0 at measured base values*);
- PSI83 Base Heart Rate: heart rate - base for calculation of PSI (*stress index equals 0 at measured base values*);
- TC\_91 Caliber A: calibration coefficient A für double sensor forehead;
- TC\_91 Caliber B: calibration coefficient B für double sensor forehead;
- TC\_91 Caliber Correction K: correction value K for double sensor forehead;
- TI\_63 Sample Rate: sample rate temperature sensor (*inner sensor double s1*);
- TO\_64 Sample Rate: sample rate temperature sensor (*outer sensor double s1*);
- T\_69 Sample Rate: sample rate temperature sensor (*outer sensor double s2*);
- T\_65 Sample Rate: sample rate temperature sensor (*inner sensor double s2*);

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Now, depending on the chosen parameter (pictured above: selection 'TC\_79 Caliber Correction K'), the desired settings can be inputted. The parameters are mainly real numbers (decimal separator '.'). Selection boxes, text strings or hexadecimal inputs are provided for specific parameters. It should be noted that the setting of sampling rate, gain and filter frequency for each channel is bound to integer dividers of a basic value. Therefore, when changed settings are transferred to the device, the values will be corrected to the next possible setting value.

Each changed parameter is separately to transmit to the satellite by clicking the button 'Write value into SAT'. Thereby the previously in the device stored values will be overwritten. Leave the configuration-dialog with 'Exit'. All satellites are preconfigured ex works. Resetting of all parameters to the factory setting is made by actuating the button 'Restore Factory Defaults'.



Note: The settings of satellites for the data capturing by HealthLab are to be chosen corresponding to the respective measuring method and the hereby resulting requirements, as well as in coordination to all measurements, which are simultaneously performed at the Satellite-Master. Doing so, optimally results while minimising the risk of a system overload will be ensured.

### 4.1.1 Channel Index

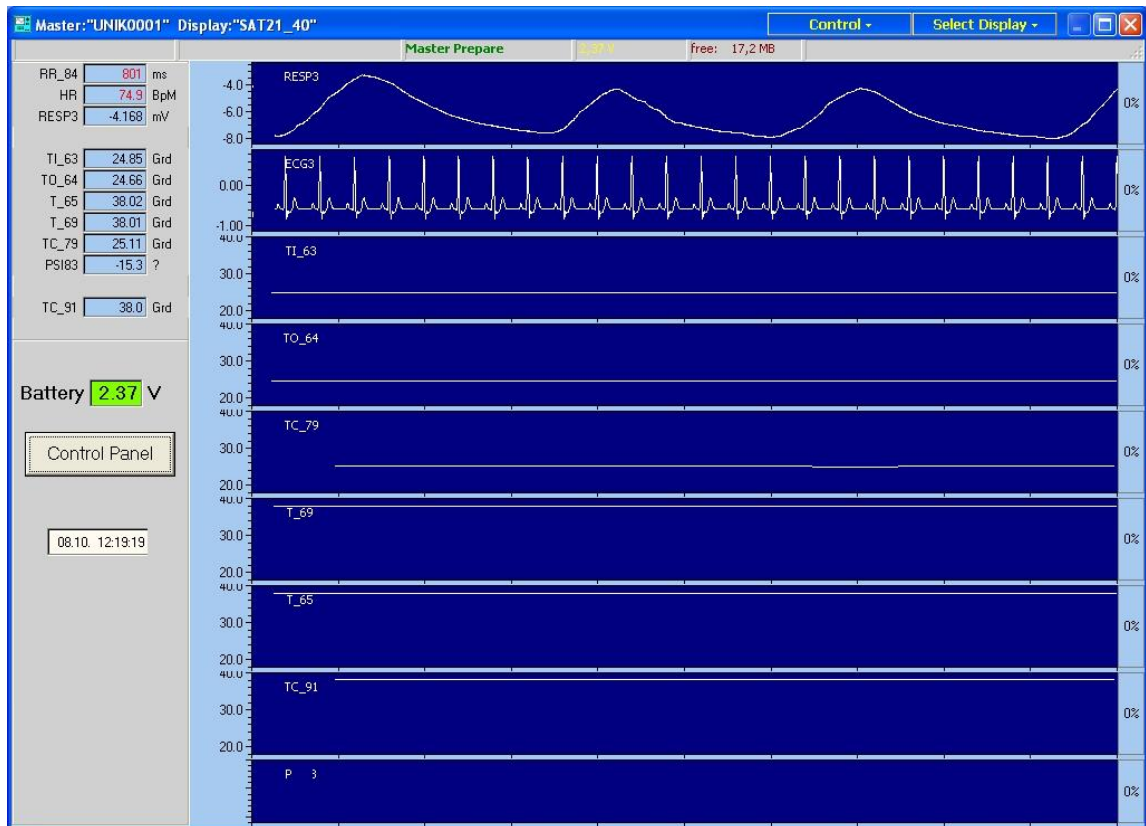
Channel-Designation	Channel No. (=Identifier)	Signal	Unit	Range Accuracy	Sample Rate Hz	Gain	Offset
ECG3	137	electrocardiogram	mV	-10 ... +10 ± 5%	4 ... 1000	150 - 8.000	2048
HR	227	heart rate	bpm	30-300	-	10	0
PSI83	83	stress index (PSI)	-	-320 ... +320	0,5	100	0
RR_84	84	heart cycle duration	ms	200 ... 2.000 ± 1	-	1	0
RESP3	138	respiration ( strap o breath sensor )	mV	0 ... 250 ± 5%	0,5 ... 125	30 – 1.500	2048
ATM85	85	breath cycle duration	s	1 ... 30 ± 0,01	-	100	-
ISP86	86	breathe in duration	s	1 ... 10 ± 0,01	-	100	-
TI_63	63	temperature sensor ( inner sensor double s1 )	°C	0 ... +50 ± 0,05	0,5 ... 125	100	0
TO_64	64	temperature sensor ( outer sensor double s1 )	°C	0 ... +50 ± 0,05	0,5 ... 125	100	0
T_65	65	temperature sensor ( inner sensor double s2 )	°C	0 ... +50 ± 0,05	0,5 ... 125	100	0
T_69	69	temperature sensor ( outer sensor double s2 )	°C	0 ... +50 ± 0,05	0,5 ... 125	100	0
TC_79	79	body core temperature ( DS 1 : TI_63, TO_64 )	°C	0 ... +50 ± 0,5	0,5	100	0
TC_91	91	body core temperature ( DS 2 : TI_65, TO_69 )	°C	0 ... +50 ± 0,5	0,5	100	0





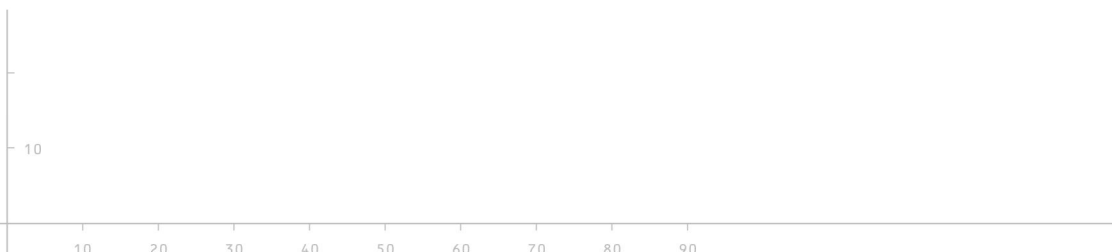


## 4.2 Evaluating the Measurement Results



By actuating the button 'Read Heally Data' within 'Heally Control', the in the Master stored measurement data are transferred to the PC system, which is used as monitoring and evaluation-system, and can then be evaluated by using the HealthLab software. In the above pictured example, various measured values of the HealthLab satellite SAT-21 on the graphical output of the program are shown:

- RESP3 shows the breathing activity of a proband.
- ECG3 represents the by means of electrocardiogram measured heart activity.
- TI\_63 and TO\_64 depict the temperature values, measured at the first temperature connector ( *double sensor respectively 2-channel NTC-Sensor* ), while TC\_79 is showing the body core temperature, calculated from these values. Analogue to this, T\_69 and T\_65 depict the measured temperature values and TC\_91 shows the calculated body core temperature from the second temperature connector.





## 5 Technical Data



*Note:* The psycho-physiological monitoring system HealthLab is manufactured and delivered in configurations according to customer's request. The HealthLab components are not certified for use in the medical field. Therefore they shall be used solely for research purposes in scientific area.

<b>Designation</b>	SAT-21.40 / ECG, respiration and temperature sensor ( satellite-type: SAT21, hardware revision: 40, firmware revision: 5.xx, channels: 13 )
<b>Power Supply</b>	3,3V ( via HealthLab Master )
<b>Power Consumption</b>	30 mA
<b>Dimensions / Weight</b>	85 x 46 x 17 mm / 50 g
<b>Capturing of Data:</b>	
<b>Electrocardiogram</b>	number of channels : 4 measuring range : -10 ... +10 mV, accuracy $\pm$ 5% sampling rate : 4 ... 1000 Hz  heart rate : 30 ... 300 heartbeats / min. heart cycle duration : 200 ... 2000 ms stress index (PSI) : -320 ... +320, sample rate 0,5 Hz
<b>Respiration</b>	measurement principle : respiration strap / breath sensor number of channels : 1 measuring range : 0 ... +250 mV, accuracy $\pm$ 5% sampling rate : 0,5 ... 125 Hz  breath cycle : 1 ... 30 sec., accuracy $\pm$ 0,05 s breathe in duration : 1 ... 30 sec., accuracy $\pm$ 0,05 s
<b>Temperature</b>	measurement principle : NTC temperature sensor / double temperature sensor number of channels : 4 ( 2x ) measuring range : 0 ... +50 °C, accuracy $\pm$ 0,1 °C sampling rate : 0,5 ... 125 Hz ( <i>body core temperature</i> : 0,5 Hz )
<b>Suppliers</b>	Koralewski Industrie-Elektronik oHG / SpaceBit GmbH

### 5.1 Ordering Information

HealthLab Measuring-Satellite	Part Number
SAT-21.40	E1433
<b>Accessories</b>	
ECG-sensor lead EKG-01	E1164
respiration strap (breath sensor) AWS-01	E1227
NTC-temperature sensor (2-channels) TPS-02	E1288
<i>Dräger temperature double sensor on request</i>	
connection cable sat.-sat. VSS-05, 0,5m	E1177
connection cable master-sat. VMS-10, 1,0m	E1176

