

**Operating Instructions**  
**for the**  
**PLUGSYS®Module**  
**EGM Einthoven Goldberger Module Type 701**

ECG amplifier for  
bipolar extremity leads after Einthoven and  
unipolar extremity leads after Goldberger

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## 1. Introduction, manufacturer's details

These Operating Instructions describe the operation and use of the **EGM** Module Type 701. It is part of the equipment and should be kept close to it.

All the information in these Instructions has been drawn up after careful examination but does not represent a warranty of product properties. Alterations in line with technical progress are reserved.

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## Trademark

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## 2. Safety note



**Warning:** the equipment is not suitable for operation in hazardous areas and/or in a flammable atmosphere.

### 3. General description, application

The **EGM** module Type 701 is a module of the HSE PLUGSYS measuring system and is used for capturing and amplifying ECG signals after Einthoven and after Goldberger. 4 electrodes are connected up. This module incorporates isolating input amplifiers in order to avoid hum interference. In this way the inputs are isolated from the output circuits and from the housing. The isolation barrier can withstand voltages up to 200 Volt.

The 6 output voltages of the different leads can be linked through jumpers to the PLUGSYS system bus. From there the signals can be taken for recording or for computerised data evaluation via a ROM module (Recorder Output Module, e.g. ROM-DL).

A square-wave calibration generator with a 1 mV amplitude is incorporated for calibrating the amplitudes.

#### Input leads

RA	right arm
LA	left arm
LF	left foot
RF	right foot (reference)

#### Output signals:

#### Bipolar Einthoven extremity leads:

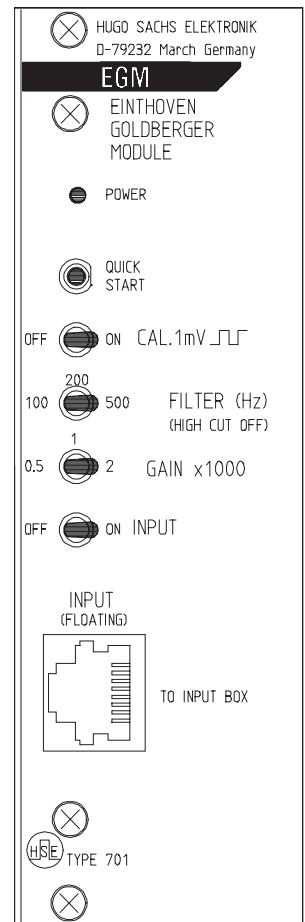
I	LA(+) - RA(-)
II	LF(+) - RA(-)
III	LF(+) - LA(-)

#### Unipolar Goldberger extremity leads:

aVR	RA(+) - (LA+LF)/2(-)
aVL	LA(+) - (RA+LF)/2(-)
aVF	LF(+) - (RA+LF)/2(-)

In addition the CTP (Central Terminal Point) signal is available at the input connector. This signal is required for operating the Wilson Lead Amplifier (WLA) PLUGSYS module Type 702. It serves as reference for the unipolar chest leads (V1 - V6) after Wilson.

For use, the EGM module has to be installed in a PLUGSYS housing Series 600.



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**Fig. 1:** Front panel

## 4. Installing the module in a housing

If you have received the module as a separate unit you should read this Section. If the module has however been supplied already installed you can omit Section 4 and continue at Section 5.

Before you can use the EGM module it has to be installed in a suitable HSE PLUGSYS housing Series 600 (July 97: 601 to 609). If the module is supplied as part of a completely installed PLUGSYS measuring system the work described below has already been carried out and the selected signal paths have been entered in the bus diagram.

### 4.1 Installation procedure

Before the module is installed in a housing the connections of the module to the bus lines have to be determined by plugging in cable jumpers as described in the next section (Sections 4.2).

Do not forget to enter the selected connections in the bus diagram (in the white Operating Manual folder for the PLUGSYS housing under Section 1).

Brief procedure (for full details see the Operating Manual of the housing):

- Pull out the mains plug on the housing.
- Remove the blank panel at the housing slot position intended for the EGM module.
- Prepare module according to Section 4.2 (set jumpers).
- Insert the EGM module, note the guide rails.
- Push the module firmly into the bus connector.
- Screw on the front panel.
- Reconnect the mains plug to the housing.
- Plug in the input cable and connect up the electrodes
- Switch on the housing

### 4.2 Internal instrument settings, jumpers

**Warning:** The EGM module has to be protected against electrostatic discharges while it is outside the housing!

The EGM module contains highly sensitive MOS components which can be damaged or destroyed by electrostatic discharges. If you are removing the module from the housing or carry out any operations on the module outside the housing you must ensure potential equilibration before touching part of the printed circuit. (Touch an earthed item, such as earthed housing, PLUGSYS housing or similar).

Before you install the EGM module into the PLUGSYS housing it is necessary to set 6 cable jumpers on the circuit board in order that the output signals are linked to the appropriate or required bus lines. The module can only be used as intended if the bus lines have been connected up correctly.

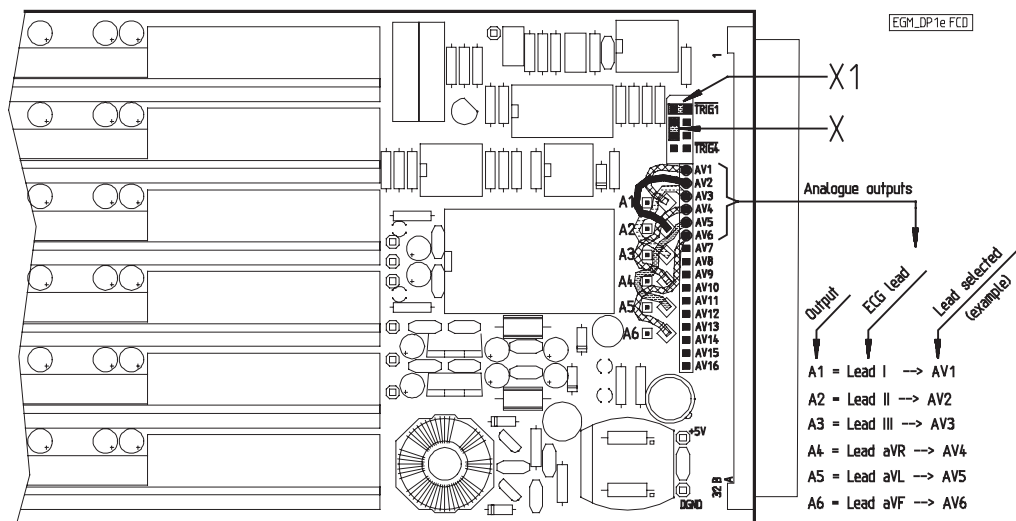
Do not forget to enter the selected signal assignment in the bus diagram for the PLUGSYS housing (the bus diagram is filed in the Operating Manual folder of the PLUGSYS housing under Section 1).

If the module is supplied as part of a completely installed PLUGSYS measuring system, the operations described below have already been completed and the selected signal paths have been entered in the bus diagram.



**Note:** When selecting the bus line (AV1...16) be sure to use a free line and check this in the bus diagram. If there is no appropriate information in the bus diagram you can determine the bus line assignment only by removing all the modules and determining the signal paths selected on them using the corresponding operating instructions.

The position of the cable jumpers is shown in Fig. 2. 6 analogue outputs (A1 to A6) have to be linked to the required bus lines (AV1 to AV16). If the "QUICK START" function is to be operated not only with the key on the front panel but also centrally via the system bus, it is necessary to set also the jumper X.



**Fig. 2:** Position of the internal jumpers

**Cable jumpers A1 to A6:** The signals of the various ECG leads are carried on the cable jumpers marked A1 to A6. The connectors of these cable jumpers have to be plugged on to the pins for the analogue bus lines (AV1 to AV16). The individual cable jumpers carry the following ECG leads:

<b>Cable jumper:</b>	<b>A1</b>	<b>A2</b>	<b>A3</b>	<b>A4</b>	<b>A5</b>	<b>A6</b>
<b>ECG leads:</b>	<b>I</b>	<b>II</b>	<b>III</b>	<b>aVR</b>	<b>aVL</b>	<b>aVF</b>

**Jumper X:** The "QUICK START" function can be activated generally by pressing the "QUICK START" key. When several amplifiers are being used simultaneously (e.g. module WLA for unipolar chest leads after Wilson) it may be desirable to operate this function centrally. In this case the jumpers X of all the modules have to be set to the same line of the trigger bus TRIG1 to TRIG4. If this trigger line is then activated, either manually by a central key or e.g. by a PC connected to this line, a quick start is performed simultaneously on all modules connected to this trigger line. As an example, Fig. 2 shows the jumper X1 set to trigger line TRIG1.

**Note**

when selecting the trigger line (TRIG1 - TRIG4), be sure to use a free line and check this in the trigger bus diagram (the trigger bus diagram is filed in the Operating Manual folder of the PLUGSYS housing under Section 1). If there is no appropriate information in the diagram you can determine the bus line assignment only by removing all the modules and determining the signal paths selected on them using the corresponding operating instructions.

Do not forget to enter the selected trigger signal assignment in the trigger bus diagram for the PLUGSYS housing (the trigger bus diagram is filed in the Operating Manual folder of the PLUGSYS housing under Section 1).

If central triggering of quick start is not required, the jumper has to be placed in the parking position (jumper **X** in Fig. 2).

## 5. Starting up

After the ECG input cable or the input box has been connected to the input socket, and to the output sockets a recorder, monitor or data acquisition system (= **visualisation unit**) you can switch on the housing.

**NOTE:** it is essential that the outputs are correctly connected to the individual channels of the visualisation unit and mark the channels with the appropriate leads (I, II, III, aVR, aVL, aVF).

Check first the function of the entire measurement system from EGM to the visualisation unit by switching off the input on the EGM, setting the gain to 1000 and switching on the calibration generator:

- set switch "INPUT" to "OFF"
- set switch "GAIN x1000" to "1"
- set switch "CAL. 1 mV" to "ON".

All outputs then show a square-wave signal with a frequency of 2 Hz (= 120 min<sup>-1</sup>) and an amplitude of 1 Volt. Now set the required amplitude on the visualisation unit by suitable adjustment of its sensitivity. In between switch off the calibration generator briefly (switch "CAL. 1 mV" to "OFF"), briefly press the "QUICK START" key (1 - 2 sec) and then adjust the required zero position on the visualisation unit.

During recording the switches should be set to the following positions:

- switch "CAL 1 mV" to "OFF"
- switch "FILTER (Hz)" to "200"
- switch "GAIN x1000" to "1"
- switch "INPUT" to "ON"

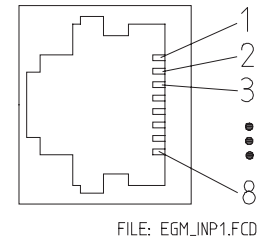
"GAIN" and "FILTER" may require a different setting depending on the actual conditions of your experiment.

## 6. Signal input

### 6.1 Input socket

The input socket of the EGM module is an 8-way Steward socket RJ-45. The front view of the socket with marking of the contact numbers is shown in Fig. 3. The contacts are used as follows:

Contact 1:	right arm ( <b>RA</b> )
Contact 2:	left arm ( <b>LA</b> )
Contact 3:	left foot ( <b>LF</b> )
Contact 4:	not used
Contact 5:	not used
Contact 6:	not used
Contact 7:	right foot ( <b>RF</b> ), reference
Contact 8:	output central terminal point (CTP)
Metal case:	screen null



**Fig. 3:** Input socket

### 6.2 Input cable

Two versions of the input cable are available as well as an input box (only in conjunction with the WLA module); they have to be ordered separately.

- (A) Input cable with 4 needle electrodes for use on small animals
- (B) Input cable with 4 banana plugs for universal use. Crocodile clips suitable for the banana plugs are available, so that many different electrode arrangements can be connected.
- (C) When using the EGM module in conjunction with the WLA module Type 702 (Wilson Lead Amplifier) the use of a special input box Type 701/2 is recommended which in addition to the extremity inputs of the EGM (RA, LA, RF and LF) provides also the 6 chest lead inputs of the WLA (V1 - V6). The connection of the CTP (from EGM to WLA) as required for the unipolar chest leads of the WLA is provided internally in the box.

## 7. Description of the controls

The item numbers in the descriptions below refer to Fig. 4.

- (1) Green LED. This lights up while the amplifier is switched on.
- (2) The "**QUICK START**" key serves to return the ECG signals quickly to the isoelectric line. This key has to be pressed for rapid "zeroing". The key acts simultaneously on all the leads.
- (3) Switch "**CAL 1 mV**". When set to "**ON**" a square-wave calibration signal with a frequency of  $120 \text{ min}^{-1}$  (2 Hz) and an amplitude of 1 mV is generated and superimposed on the input signal. With the input switched off (switch INPUT set to OFF) the output carries the pure calibration signal.

The calibration signal appears simultaneously on all leads.

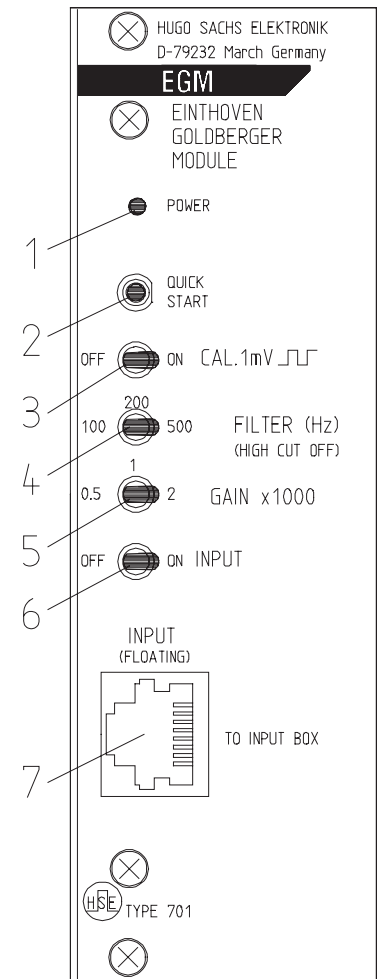
The amplitude 1 mV is referred to the input and serves for evaluating the amplitude of the ECG signal. The calibration signal appears with different amplitudes depending on the selected gain setting (switch GAIN); at GAIN = 1000, output = 1 V; at GAIN = 500, output = 0.5 V; at GAIN = 2000, output = 2 V.

- (4) Switch "**FILTER (Hz)**" ("**HIGH CUT OFF**") is used to set the upper frequency limit. This filter permits some smoothing of the ECG signal. When selecting the filter setting, note that "excessive filtering" may reduce the amplitude of the steep parts of the trace (R-wave)!

The switch setting should therefore always be selected from the top downwards, i.e. always start with 500 Hz, then switch to the lower steps (200 Hz - 100 Hz) and observe the amplitude (height of the R-wave). With excessive filtering the amplitude of the R-wave is reduced and the trace is no longer true.

The filter acts simultaneously on all leads.

- (5) Switch "**GAIN x1000**". This switch selects the amplification for all leads simultaneously. The actual gain is obtained by multiplying the selected switch position by 1000: at "0.5" the gain is then x500, at "1" it is x1000, and at "2" it is x2000.
- (6) Switch "**INPUT**". Using this switch all signal inputs can be simultaneously switched on (position ON) and switched off (position OFF). The setting of the switch does not affect the input impedances of the input circuit.
- (7) Input socket (RJ45), 8-way (for details see Section 6.1). The input circuit of the isolating amplifier has a floating input and can withstand voltages up to 200 V DC.



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**Fig. 4: Controls**

## 8. Frequent errors, causes and remedies

**Error:** No output signal, although input cable is connected correctly.

**Cause:** Input switched off.

**Remedy:** Set switch "**INPUT**" to "**ON**".

**Error:** Signal amplitude very small. Deflection on recorder or screen barely visible.

**Cause:** Amplification "**GAIN**" too small.

**Remedy:** Increase amplification (switch "**GAIN**"). The recorder or monitor used may not have sufficient sensitivity.

**Error:** Interference on the ECG signal through "mains hum" (superimposed 50 Hz interference).

**Cause:**

- Not all the 4 electrode leads are connected up.
- There is a source of 50 Hz interference close to the electrodes (mains cable, lamp etc.)
- Electrode resistances are too high.

**Remedy:**

- Check the electrode leads for proper connection to the electrodes.
- Search for source of 50 Hz interference and remove it, or provide screening to prevent interference pick-up.
- High electrode contact resistances enhance interference pick-up. Check electrode contact and improve if necessary.

**Error:** R-wave not clearly defined but flattened.

**Cause:** Excessive filtering, selected filter step is too low.

**Remedy:** Set filter "**HIGH CUT OFF**" to 500 Hz and observe the recorder. Switch down to 200 Hz and 100 Hz and watch the shape of the R-wave. The R-wave must not change its height, otherwise the selected filter step is too strong.

**NOTE:** for representing the R-wave of an ECG signal at the correct amplitude the recorder must have a sufficiently high frequency limit (30 - 100 Hz). "Slow" potentiometric recorders, so-called laboratory recorders (usually with a width of 250 mm) are not suitable.

**Error:** Output shows only square-wave signals.

**Cause:** The Cal generator is still switched on and the input is switched off.

**Remedy:** Set switch "**CAL. 1 mV**" to "**OFF**" and switch "**INPUT**" to "**ON**".

## 9. Maintenance and cleaning

The PLUGSYS modules do not really require any maintenance. The EGM module is supplied fully calibrated. Any contact with or modification of the electronic circuit invalidates the warranty and the product liability of the manufacturer.

The front panel can be cleaned if necessary with a slightly moistened (not wet!) cloth. Before cleaning, always pull out the mains supply plug to ensure operator safety!

No moisture must find its way into the unit and especially not into the switches and keys, since this leads to corrosion at the switch contacts resulting in faulty operation. In general the PLUGSYS housing should be protected against splash water and salt solutions as this may damage individual components and may cause a short-circuit!

## 10. Transport and storage

In order to avoid transport damage when returning the unit to the factory, the PLUGSYS housing should be packed in a suitably large carton. (The carton should allow a spacing of about 10 cm all round to provide sufficient space for padding material, e.g. polystyrene, foam plastic or similar, to absorb any shocks.) When shipping an individual module it should also be protected by adequate padding and should first be enclosed in antistatic foil or envelope.

## 11. EC Declaration of Conformity



This product and accessories conform to the requirements of the Low-voltage Directive 73/23 EEC as well as the EMC Directive 89/336 EEC and are accordingly marked with the CE mark. For conformity to the standards during operation it is essential that the details in the instructions provided are observed.

12. Block diagram of the EGM module

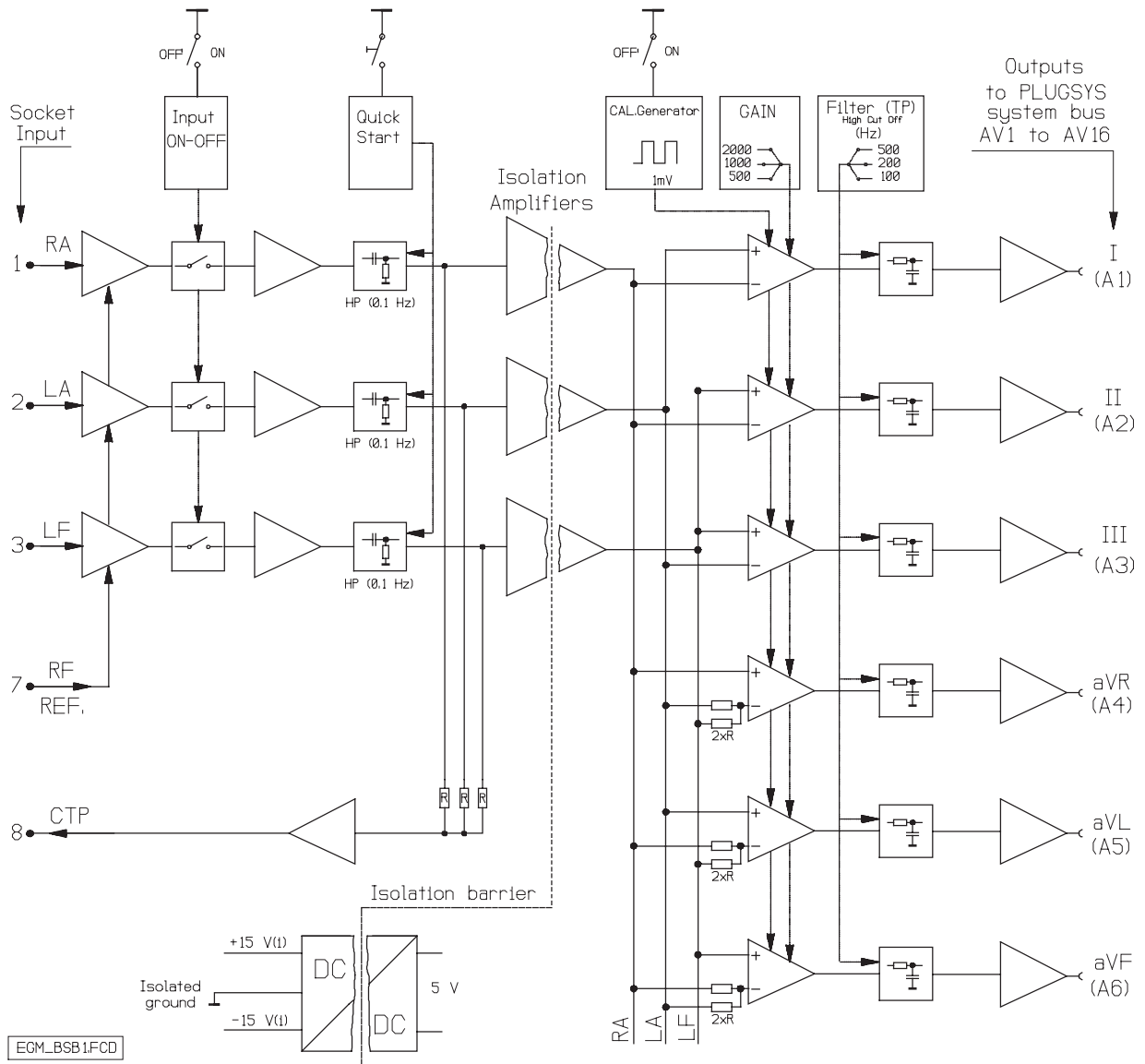


Fig. 5: Block diagram

**13. Technical data**

ECG leads:	bipolar extremity leads after Einthoven: I, II and III, also unipolar extremity leads after Goldberger: aVR, aVL and aVF.
ECG input:	the input cable is a 4-way cable and has to be connected as follows: RA (right arm), LA (left arm), LF (left foot) and RF (right foot).
Input circuit:	isolated input circuit (floating input), max. isolation voltage 200 V DC
Input impedance:	$10^7$ Ohm
Filter:	low-pass filter 100 Hz, 200 Hz and 500 Hz high-pass filter 0.1 Hz, fixed
Gain:	in position x0.5 500 in position x1 1000 in position x2 2000
Calibration:	square-wave signal 1 mV, 2 Hz ( $120 \text{ min}^{-1}$ ). The calibration signal is switched on with a toggle switch.
Recorder outputs:	the outputs of the 6 ECG leads are linked to the PLUGSYS bus system by cable jumpers. The connection to the recorder is made through the Recorder Output Module (ROM) installed in the PLUGSYS system.
Ambient conditions:	operating temperature: 10 to 40°C humidity: 20 to 80% rH, no condensation storage temperature: -20 to +60°C
Supply:	5 V 1.2 A, supplied through PLUGSYS system bus

**Mechanical data:**

Dimensions:	module for PLUGSYS housing width 8 E (40.8 mm) height 3 U (128.7 mm) depth Eurocard (220 mm)
Connector:	DIN 41612, 96-way VG connector RJ-45, 8-way
Weight:	430 g
Accessories:	Operating Instructions
Input cable: (must be ordered separately)	- 4-way ECG input cable with needles, or - 4-way ECG input cable with banana plugs, or - input box Type 701/2 with 4 + 6 inputs for simultaneous use of a WLA module Type 702 for 6 unipolar chest leads after Wilson (V1 - V6).