Operating Instructions

for the

PLUGSYS® Module

ECGA Electrocardiogram Amplifier Type 689

(Version: 1.2 / Print date: July 1, 2013 from Ser.No. 95001 / T. Beha)

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1. Introduction, manufacturer's information

These Operating Instructions describe the function and the use of the **ECGA** module Type 689. It forms an essential constituent of the instrument and should be stored close to it.

All the information in these instructions have been assembled after careful examination but do not represent any warranty of product properties. Modifications in line with technical progress are reserved.

This PLUGSYS® module is manufactured by:

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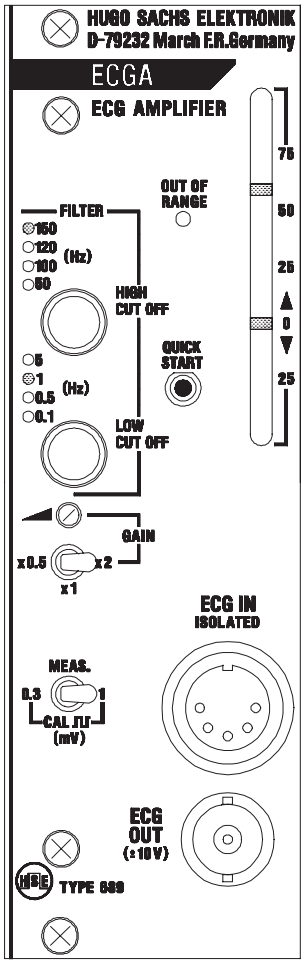
2. Safety note

Warning: The instrument is not suitable for use in hazardous areas and/or in an inflammable atmosphere.



3. General description, application

The **ECGA** module Type 689 is a module for the HSE PLUGSYS measurement system and serves for measuring and amplifying ECG signals. The input of this module incorporates an isolation amplifier in order to avoid hum interference. This provides isolation between the input circuit and the output circuit and housing. The isolation barrier is capable of withstanding voltages up to 300 Volt.

The signal is indicated on a bargraph display.

The frequency response of this module is arranged so that it can handle ECG signals up to 1000 bpm (beats per minute).

The ECG signal is available as analogue voltage for recording at a BNC socket on the front panel and internally on the PLUGSYS system bus.

A square-wave calibration generator with amplitudes of 0.3 mV and 1 mV is incorporated to calibrate the ECG amplitudes.

Before the **ECGA** module can be used it has to be installed in a PLUGSYS housing Series 600.

4. Installing the module in a housing

(If the module has been supplied already installed you can omit Sections 4 and 5 and continue with Section 6. If you have received the module as a separate unit you should continue here.)

Before you can use the **ECGA** module it has to be installed in a suitable HSE PLUGSYS housing Series 600 (Jan. 95: 601 to 607). 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.

Before the module is installed in a housing the connections of the module to the bus lines have to be determined by plugging in links as described in the next section (Section 5).

Do not forget to enter the selected connections in the bus diagram (in the white Operating Manual folder 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(s) at the housing slot position intended for the **ECGA** module.
- Prepare the module according to Section 4 (set lines and links).
- Insert the **ECGA** module, note the guide rails.
- Push the module firmly into the bus connector.
- Screw on the front panel.
- Plug in the ECG cable.
- Reconnect the mains plug to the housing.
- Switch on the housing.

4.1 Internal instrument settings, links

Warning: the **ECGA** module must be protected against electrostatic discharges while it is outside the housing!

The **ECGA** module contains highly sensitive MOS components which can be damaged or destroyed by electrostatic discharges. If you dismantle the module or if you carry out any operations on the dismantled module you must ensure potential equilibration before touching any part of the printed circuit (by touching some grounded metal part, e.g. water tap, central heating radiator, grounded housing, PLUGSYS housing or similar).

Before you install the **ECGA** module into the PLUGSYS housing it is necessary to set a link on the circuit board so that the output signal is linked to the appropriate or required bus line. The module can only be used in conjunction with the complete system if the bus line has 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 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.

You find the position of the links from the diagram below. The following link has to be set:

Signal output for ECG to PLUGSYS bus system

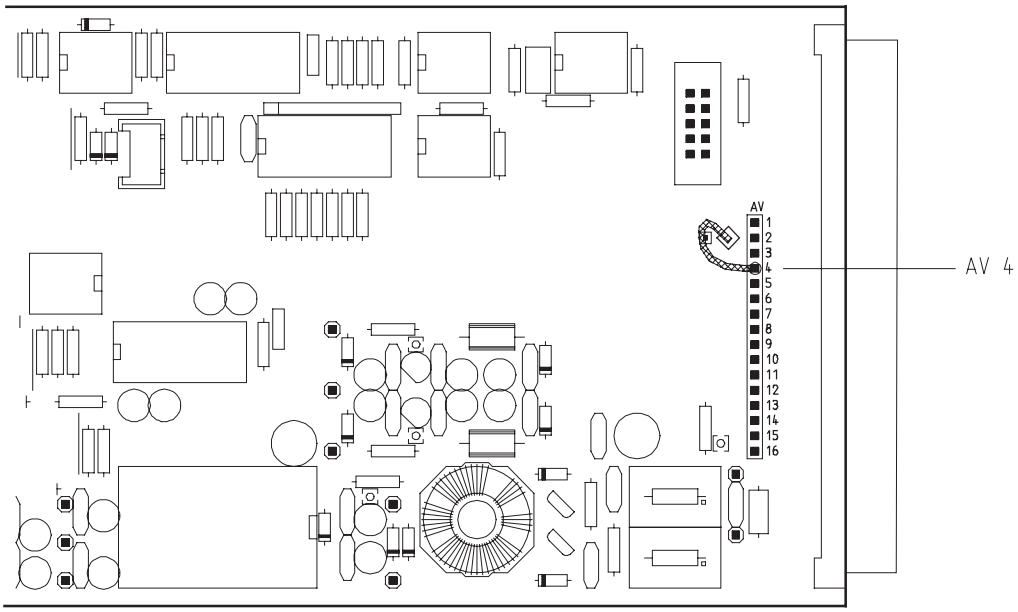


Fig. 2: Position of the internal link

In the example shown above the signal output has been set so that the analogue ECG signal is on bus line AV 4.

5. Starting up

After the ECG input cable has been connected to the input socket you can switch on the housing and start the measurement.

5.1 Arranging an ECG signal on the recording chart, calibration

The **ECGA** module incorporates a calibration generator for 0.3 mV and 1 mV; this can be switched on by moving the switch **"0.3/MEAS/1"** to the appropriate position.

In the description below it is assumed that the instrument is switched on, ready for use, and connected to a recorder with a recording width of 8 cm per channel.

It is of course possible to use some other recorder with a different recording width and chart scale. An important requirement would however be an adequate input sensitivity of at least 1 Volt full scale.

Basic details:	
Range required:	-1 mV to 1 mV
Recording width:	80 mm
Chart graduations:	centimetre and millimetre

With these details you should use the 1 mV calibration setting.

The recording range can be adjusted so that it accurately fits the chart graduations. The procedure is as described below.

(A) Set switch **"0.3/MEAS/1"** to **"MEAS"**.

(B) Short-circuit the three input electrodes.

(C) Set filter **"HIGH CUT OFF"** to 150 Hz.

(D) Set filter **"LOW CUT OFF"** to 0.1 Hz.

(E) Set **"GAIN"** switch to **"x1"**.

(F) On the recorder set the pen with the position control to the centre of the recording range.

(G) Move switch **"0.3/MEAS/1"** to **"1 mV"**. The module now outputs a calibration signal with a 1 mV amplitude (from -0.5 mV to +0.5 mV). The shape of the signal depends on the filter setting.

(H) Now adjust the recorder sensitivity so that the pen has a deflection of 4 cm (±2 cm around the zero line).

Now 2 cm = 0.5 mV or 1 cm = 250 µV. The maximum deflection of ±4 cm corresponds to a voltage of ±1 mV.

(I) If the recorder does not have a fine sensitivity adjustment the PLUGSYS module **ROM** Type 670 can be used to attenuate the output signal of the ECG. Using a screwdriver you can reduce the output voltage by anticlockwise rotation on the appropriate channel.

(J) If you do not have a **ROM** you have to use a screwdriver to alter the **"GAIN"** potentiometer of the ECG amplifier to adjust the amplification so that you obtain the required 4 cm deflection.

After completing this procedure you have arranged the required scale on the recorder. If now you move the switch **"0.3/MEAS/1"** to its centre position **"MEAS"** you can record the ECG.

As a check you can switch back occasionally to **"1" or "0.3"** and check the pen deflections.

If you adjust the filter during the experiment you should check the calibration again and if necessary make a fine adjustment.

If the ECG signal goes beyond the selected range you can move the switch **"x0.5/x1/x2"** to position **"x0.5"** and thereby halve the amplitude.

If the ECG signal appears too small you can move the switch **"x0.5/x1/x2"** to position **"x2"** and thereby double the amplitude.

Please note:

Every alteration in the amplification on the **"GAIN"** switch or on the potentiometer also changes the calibration of the output amplitudes !

The best way to avoid mistakes, after changing the amplification, consists of moving the switch **"0.3/MEAS/1"** to position **"1"** and to check the deflection which always corresponds to 1 mV.

Important: In position 1 mV the square-wave signal is output with 1 mV jumps. Due to the automatic return of the signal to the zero line (AC coupling) the square-wave signal jumps from -0.5 mV to +0.5 mV (amplitude 1 mV).

In position 0.3 mV a square-wave signal with 0.3 mV jumps is produced. Through the automatic return of the signal to the zero line (AC coupling) the square-wave signal then jumps from -0.15 mV to +0.15 mV (0.3 mV amplitude).

The shape of the calibration signal alters with the filter setting **"LOW FILTER CUT OFF"**. The signal shown here applies only to the 0.1 Hz filter setting.

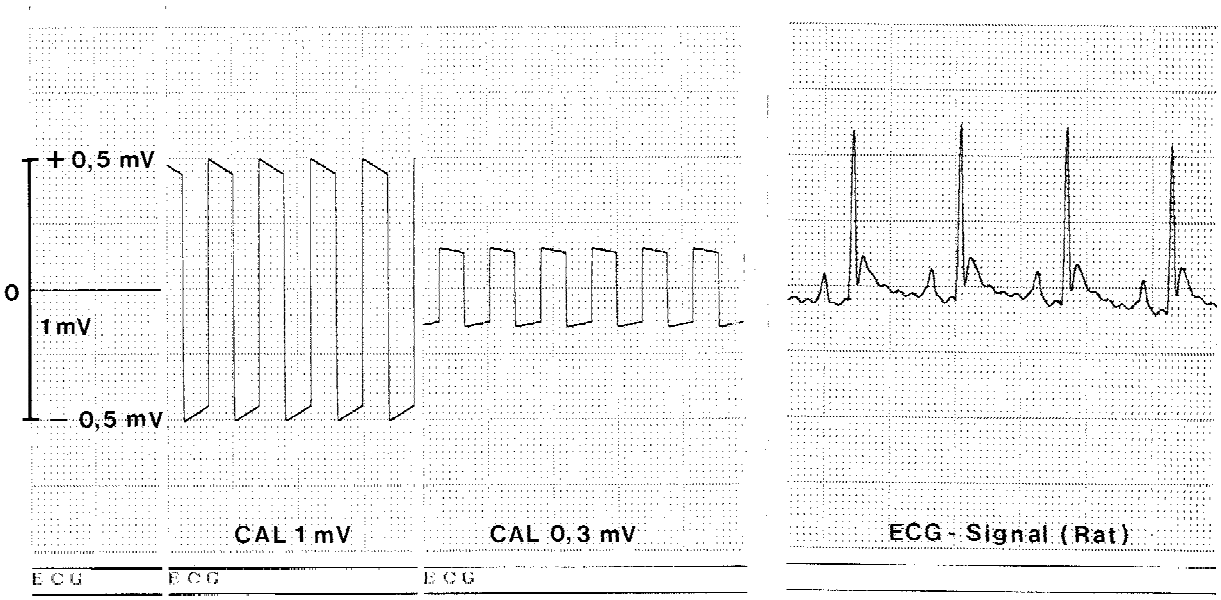


Fig. 3: Setting up an ECG scale on the chart, selected range ±1 mV, see text above.

Example 2: (see Fig. 4)

Basic details:	
Range required:	-0.5 mV to +0.5 mV
Recording width:	80 mm
Chart graduations:	centimetre and millimetre

With these details you should use the 1 mV calibration setting.

The recording range can be adjusted so that it accurately fits the chart graduations. The procedure is as described below.

(A) Set switch **"0.3/MEAS/1"** to **"MEAS"**.

(B) Short-circuit the three input electrodes.

(C) Set filter **"HIGH CUT OFF"** to 150 Hz.

(D) Set filter **"LOW CUT OFF"** to 0.1 Hz.

(E) Set **"GAIN"** switch to **"x1"**.

(F) On the recorder set the pen with the position control to the centre of the recording range.

(G) Move switch **"0.3/MEAS/1"** to **"1 mV"**. The module now outputs a calibration signal with a 1 mV amplitude (from -0.5 mV to +0.5 mV). The shape of the signal depends on the filter setting.

(H) Now adjust the recorder sensitivity so that the pen has a deflection of 8 cm (±4 cm around the zero line).

Now 4 cm = 0.5 mV or 1 cm = 125 µV. The maximum deflection of ±4 cm now corresponds to a voltage of ±0.5 mV.

(I) If the recorder does not have a fine sensitivity adjustment the PLUGSYS module **ROM** Type 670 can be used to attenuate the output signal of the ECG. Using a screwdriver you can reduce the output voltage by anticlockwise rotation on the appropriate channel.

(J) If you do not have a **ROM** you have to use a screwdriver to alter the **"GAIN"** potentiometer of the ECG amplifier to adjust the amplification so that you obtain the required 8 cm deflection.

After completing this procedure you have arranged the required scale on the recorder. If now you move the switch **"0.3/MEAS/1"** to its centre position **"MEAS"** you can record the ECG.

As a check you can switch back occasionally to **"1"** or **"0.3"** and check the pen deflections.

If you adjust the filter during the experiment you should check the calibration again and if necessary make a fine adjustment.

If the ECG signal goes beyond the selected range you can move the switch **"x0.5/x1/x2"** to position **"x0.5"** and thereby halve the amplitude.

If the ECG signal appears too small you can move the switch **"x0.5/x1/x2"** to position **"x2"** and thereby double the amplitude.

Please note:

Every alteration in the amplification on the **"GAIN"** switch or on the potentiometer also changes the calibration of the output amplitudes !

The best way to avoid mistakes, after changing the amplification, consists of moving the switch **"0.3/MEAS/1"** to position **"1"** and to check the deflection which always corresponds to 1 mV.

The shape of the calibration signal alters with the filter setting **"LOW FILTER CUT OFF"**. The signal shown here applies only to the 0.1 Hz filter setting.

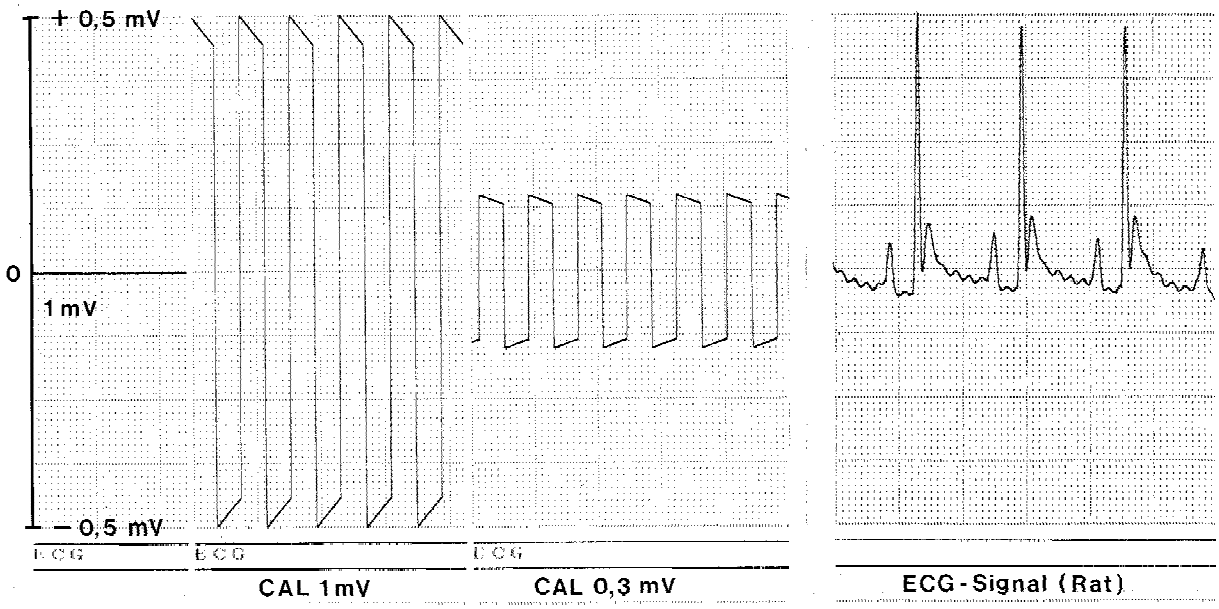


Fig. 4: Setting up an ECG scale on the chart, selected range ±0.5 mV, see text above.

6. Input pin connections

The **ECGA** module has a 5-pin Binder input socket with screw lock for an HSE ECG input cable. Only pins 1, 2 and 3 are used.

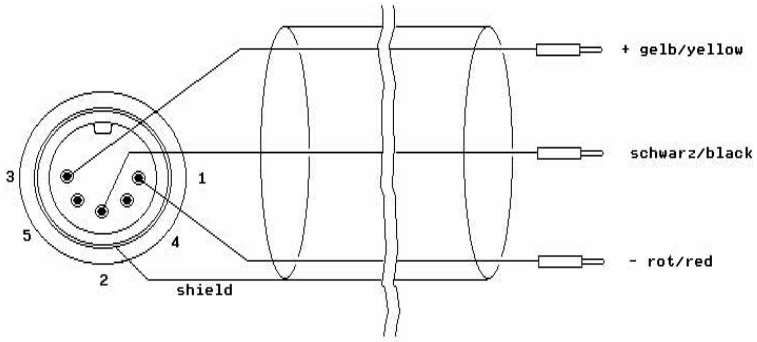
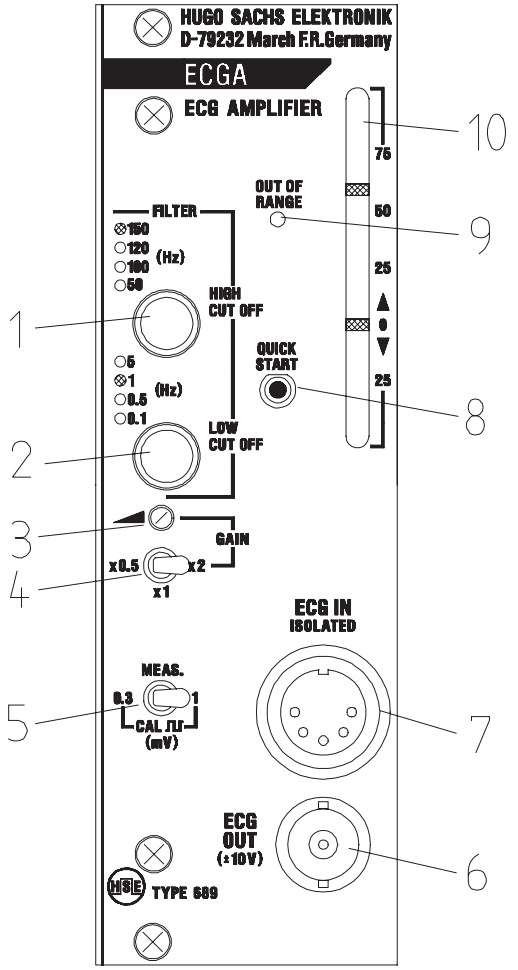


Fig. 5: Input socket for 3-pin plug

No. 09-0305-00-03
HSE No. #H11013

Alternatively a 5-pin input plug Nr. 09-0017-00-05, HSE No. #H11011 can be used.

7. Description of the controls



(1) Knob **"FILTER HIGH CUT OFF"** is used to set the upper frequency limit. This filter can be used to smooth the recording traces. It is important, however, to ensure always that filtering does not change the amplitude !

The adjustment is always made from the top downwards, i.e. always starting on 150 Hz, then switching down to 120 Hz and noting the amplitude (height of the R wave). The amplitude should not be reduced, otherwise filtering is already too strong.

The heart rate alters with the animal species used. Rats, for example, have a heart rate up to 600 bpm and frequency components up to 120 Hz in the ECG signal. In this case the setting should always be 150 Hz or 120 Hz. With species having a lower heart rate it is possible to move to lower filter settings; however the amplitude of the R wave must always be checked.

(2) Knob **"FILTER LOW CUT OFF"** is used to set the lower frequency limit. This filter is used to set the time required by the signal to return to the isoelectric line (also known as AC coupling). A superimposed myogram, usually caused by thorax movement, can be filtered out through the setting of this filter.

(3) This is a fine adjustment of the amplification (GAIN) using a screwdriver. If the amplitude of the ECG signal is too large it can be reduced here. This fine adjustment is always linked to the switch **"x0.5/x1/x2"**. During setting up it is preferable to use the **"x1"** position so that with an amplitude decrease or increase it remains possible to halve (x0.5) or double (x2) the signal without recalibration.

(4) Coarse amplification adjustment (GAIN) using the switch **"x0.5/x1/x2"**. During setting up it is preferable to use the **"x1"** position so that with an amplitude decrease or increase it remains possible to halve (x0.5) or double (x2) the signal without recalibration.

(5) Switch **"0.3/MEAS/1"** to switch between calibration and measurement. The centre position is the measurement position. In position **"0.3"** a calibration of 0.3 mV is simulated. AC coupling produces in this case a phasic signal with an amplitude of ±0.15 mV and the frequency of 3Hz (180 bpm) about the zero line.

In position **"1"** a signal with an amplitude ±0.5 mV appears at the output.

Please note: after a change in the filter setting the calibration should be re-checked since a change in the filter may also influence the amplitude depending on the frequency of the ECG signal.

(6) BNC sockets ECG OUT (±10 V). This socket carries the output signal in the voltage range ±10 V. This socket can be used for connection to a recorder or oscilloscope.

(7) Isolated 5-pin input socket. The input circuit of the isolation amplifier can withstand voltages up to 300 Volt !

(8) Key **"QUICK START"** is used to return the ECG signal quickly to the isoelectric line. Press this key for rapid zeroing.

(9) LED **"OUT OF RANGE"**. This LED lights up as soon as the voltage range of ±10 V is exceeded, The amplification (GAIN) is then too high and has to be reduced at the **"GAIN"** fine control or at the switch **"x0.5/x1/x2"**.

(10) LED bargraph to visualise the ECG signal.

8. Faults, their causes and remedies

- LED **"OUT OF RANGE"** flashing
Amplification (GAIN) too high, R wave overloads ECG amplifier

Remedy: Reduce amplification. Turn **"GAIN"** trimmer anticlockwise until LED **"OUT OF RANGE"** no longer flashes. Then turn GAIN further down until the amplitude on the bargraph is 75 - 80% of full scale.

- Signal amplitude very small, deflection on bargraph hardly visible. Amplification (GAIN) too low.

Remedy: Increase amplification. Move switch to position **"x1"**. Turn **"GAIN"** trimmer clockwise until the deflection on the bargraph is 50 - 75%. If this is not yet sufficient, move switch to position **"x2"** and turn down **"GAIN"** trimmer anticlockwise until the bargraph deflection is 50 - 75%.

- R-wave not particularly pronounced. Possibly excessive filtering.

Remedy: Move filter **"HIGH CUT OFF"** to 150 Hz and check recorder. Perhaps switch down to 100 Hz. Height of the R wave must not change, otherwise filtering is excessive.

- Output shows only square-wave signal. Cal generator is still switched on.

Remedy: Move switch **"0.3/MEAS/1"** to position **"MEAS"**.

- ECG reversed on the recorder.

Remedy: Interchange red and yellow ECG needles or plugs.

9. Maintenance and cleaning

The PLUGSYS module essentially does not require cleaning. The **ECGA** module is supplied fully calibrated. Any operation on or alteration of the electronic circuitry invalidates the manufacturer's warranty and product liability.

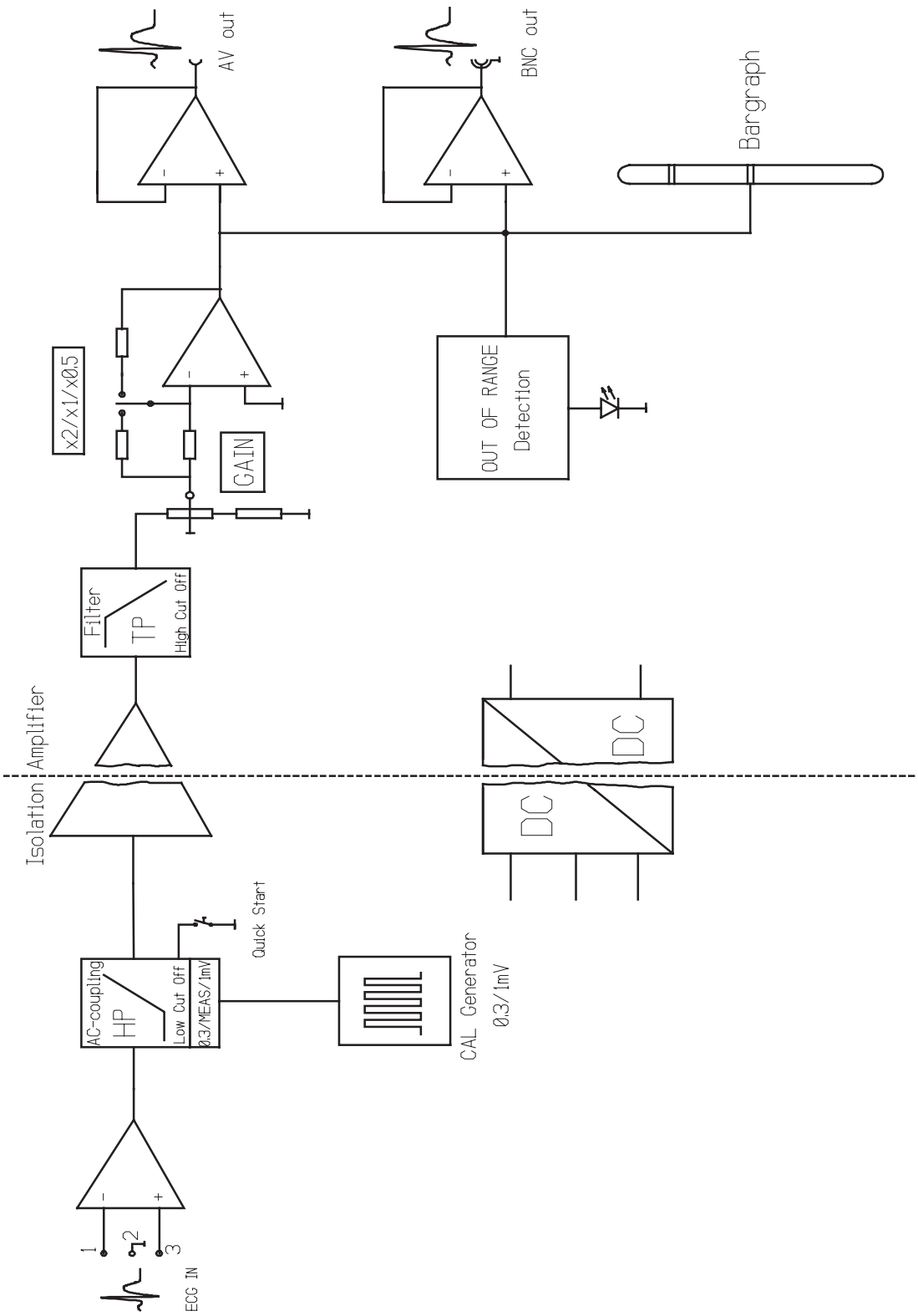
The front panel can be cleaned if necessary with a lightly moistened (not a wet) cloth. Before cleaning always pull out the mains supply plug!

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 water splashes 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 if the unit has to be returned 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 so that sufficient packing material such as polystyrene, hard foam panel or similar can be included to protect against impact damage). When shipping individual modules these should also be well packed and enclosed in antistatic foil or envelope.

11. Block diagram of the ECGA module



12. CE Declaration of Conformity

CE 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.

13.Technical data

Input:	insulated differential input, max. insulation 300 V
Input impedance:	10^{10} Ohm
Common mode suppression:	106 dB
Filters:	low-pass filter 150 Hz, 120 Hz, 100 Hz, 50 Hz high-pass filter 5 Hz, 1 Hz, 0.5 Hz, 0.1 Hz
Amplification:	**"GAIN"** trimmer fully clockwise position x0.5 5 000 position x1 10 000 position x2 20 000 **"GAIN"** trimmer fully anticlockwise position x0.5 1 000 position x1 2 000 position x2 4 000
Indication:	bargraph 0.75 V/LED
Outputs:	BNC socket on front panel (±10 V, 5 mA max.) The output voltage is also available on the PLUGSYS bus system.
Calibration:	square-wave signal 0.3 mV and 1 mV selected by switch
Recorder outputs:	the internal output is linked to the PLUGSYS bus system through a link. The ECG signal is connected to a recorder via a Recorder Output Module installed in the PLUGSYS system. An alternative direct connection at the BNC socket on the front panel is available.
Ambient conditions:	working temperature: 10 to 40°C rel. humidity: 20 to 80%, no condensation storage temperature: -20 to 60°C
Supply:	5 V 600 mA via 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)
Connectors:	DIN 41612, 96-pin VG connector Binder plug, 5-pin
Weight:	400 g
Accessories:	ECG input cable, BNC output cable, Operating Instructions