
Operating Instructions
for the
Peak Height Detector Amplifier PHDA
after COURTICE
for extracellular potentials Type 683
(Version 1.2 / Printed April 12, 2011 / H.Steiert)

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1. Introduction, manufacturer's details

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Trademark

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2. Safety note



Important:

This equipment is not suitable for operation in hazardous areas and/or in a flammable atmosphere.

The equipment is not approved for measurement on humans!

3. Literature note

This module has been developed for the special experimental set-up after STEVE MARSH for measuring extracellular potentials on isolated sympathetic ganglia and intact nerve bundles in the rat. A detailed description of the method used will be found in the publication "BIOLOGICAL MEASUREMENT TECHNIQUES VI - EXTRACELLULAR RECORDING FROM RAT SYMPATHETIC GANGLIA AND WHOLE NERVE BUNDLES" by Steve Marsh, published 1989 in the Series "Methods in Experimental Physiology and Pharmacology" by Bionesttechnik-Verlag March GmbH, D-79232 March-Hugstetten, Germany.

4. General description, applications

The Peak Height Detector Amplifier (PHDA) Type 683 is a module suitable for the HSE PLUGSYS measuring system. For operation it has to be installed in a PLUGSYS Series 600 housing (1990: 600 - 607) fitted with power supply.

The PHDA is used for the capture of peak values of the amplitude of individual evoked nerve pulse signals. It allows the user to monitor simultaneously small d.c. signals (membrane rest potential) and the amplitude of a selected proportion of an evoked potential.

In order to ensure short connecting lines to the recording electrodes the differential input amplifier is located in a small input box. This input box is plugged with its 8-pin plug into the PHDA.

Interfering error voltages (d.c. offsets) at the electrodes can be compensated to zero using a built-in 10-turn potentiometer. The action of the offset potentiometer can be switched off so that the full height of the d.c. input voltage can be measured and read on the built-in digital voltmeter (range: 19.99 Volt). The selected amplification factor "GAIN" must of course be allowed for.

The detector output which can be connected to an X-T recorder, permits continuous recording of changes in the potential differences (membrane potentials) and of the superimposed evoked peak amplitudes, either simultaneously on a single trace or the two signals separately on two traces. The recording sensitivity of the appropriate recorder channels allows very small changes in membrane potential to be reproduced.

An additional output for the amplified a.c. signal (AC) permits monitoring the evoked potentials on an oscilloscope and adjusting the time window for the peak height detector.

The PHDA is available in two different versions with front panels of different widths. In the wider version all output signals are available both on the system bus and also at BNC sockets on the front panel. The narrower version (S in Fig. 2) has all signals available on the system bus, only the selectable output "PEAK - (PEAK+DC)" is accessible on the front panel.

In general the wider version is preferable. The narrow version is useful only in the case of a larger system with various other additional modules in the PLUGSYS housing so that there is insufficient space.

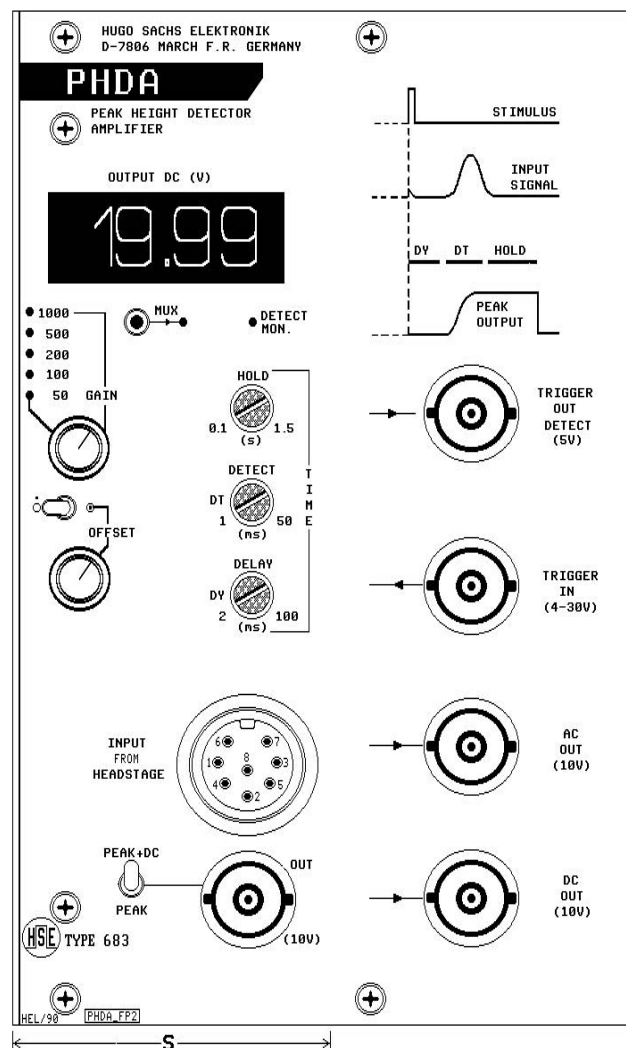


Fig. 2: Front panel of the PHDA

5. Experimental set-up

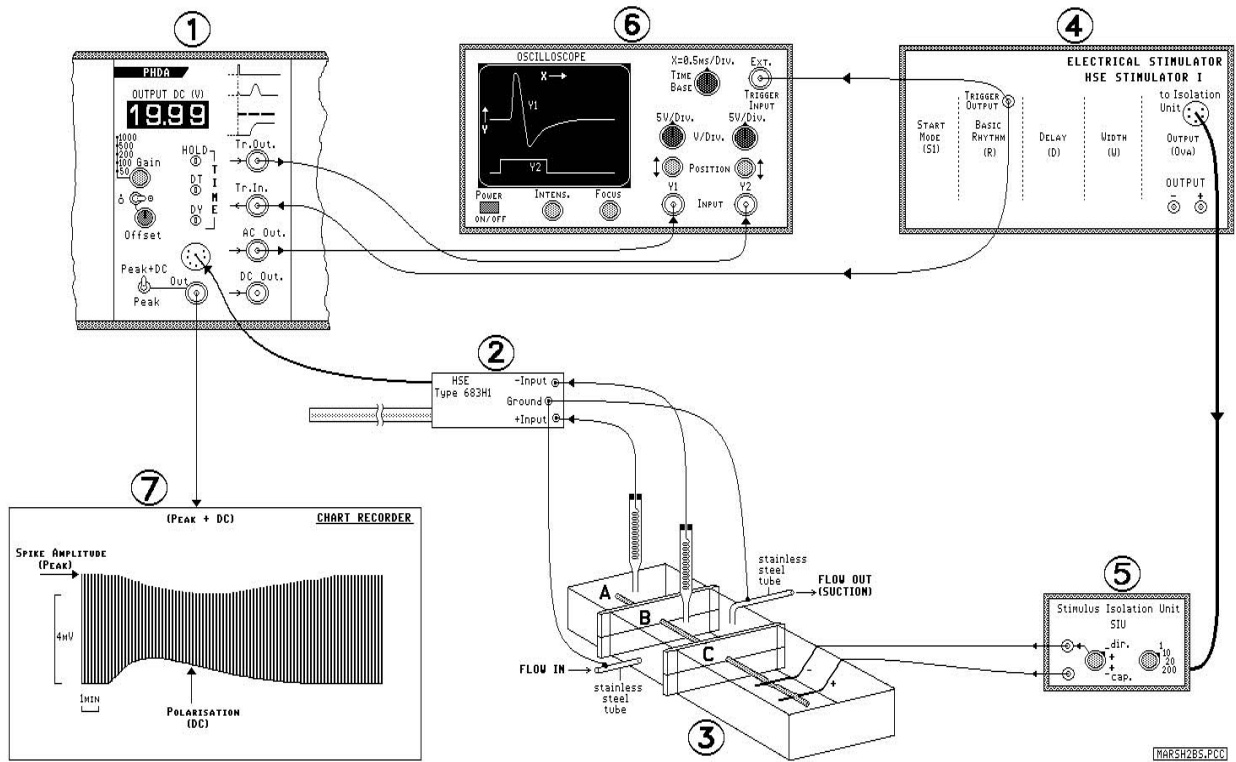


Fig. 3: Typical experimental set-up for measurement with the PHDA. For description see text.

Fig. 3 shows schematically a typical experimental set-up for measuring substance-induced membrane polarisation and the evoked potential amplitude of an entire nerve bundle and ganglion (rat). The tissue vessel (3) with 3 chambers contains the nerve bundle on which the experiment is being performed. The nerve bundle is placed into the centre chamber B and projects at both ends into the adjacent chambers A and C. The chambers are electrically isolated from each other. The part of the nerve bundle on which potentials are being measured has to be in the centre chamber (B). In chamber C the nerve rests on two stimulation electrodes (platinum wire). The potential difference in the chambers A and B (EA and EB) is measured by means of two Ag/AgCl electrodes and passed to the input amplifier (683 H1) of the PHDA. The inlet and outlet tubes (stainless steel) for the perfusion solution in the centre chamber serve as reference electrode of the bath and are connected to the "ground" socket of the input box.

In addition to the Ganglion Bath after Marsh (3), the PHDA Type 683 (1) with the necessary PLUGSYS housing and the input amplifier Type 683 H1 (2), the set-up requires the following items:

- 2 recording electrodes E_A and E_B (Ag/AgCl immersed in agar as conducting medium, see Publication VI/89, Literature References)
- Electrical stimulator (4) with stimulus isolation unit (5), e.g. HSE Stimulator I with Stimulus Isolation Unit SIU Type 261.
- 2-channel storage oscilloscope (6), e.g. Hitachi VC-6025
- 2-channel recorder (7), e.g. GRAPHTEC Mark VII-2DL

The connections for the measurement and trigger signals as required for operation are shown in Fig. 3. This figure illustrates the version of the PHDA with the wide front panel. When using the narrow version the 4 BNC sockets (right side) are omitted. In that case the signal paths have to be taken from the bus diagram (the bus diagram will be found in the Operating Instructions of the housing Type 600...607).

6. Starting up, adjustment, experimental procedure

- 1 Connect up the equipment as shown in Fig. 3. Leave the instruments switched off and select the base settings as indicated below.
- 2 On the PHDA set the gain to 1000.
- 3 On the oscilloscope set the sensitivity of signal input Y1 = 2 V/div, for the detect input Y2 = 5 V/div, and the time base on 10 msec/div.
- 4 Set the stimulator output and the output of the stimulus isolation unit to 0 Volt.
- 5 On the stimulator set the base rhythm to 5 seconds (or the frequency to 0.2 Hz).
- 6 Switch on the instruments.
- 7 Synchronise the oscilloscope time base with the base rhythm of the stimulator (on the oscilloscope select "extern trigger", "+slope", trigger mode: "Norm":
- 8 On the PHDA set the controls HOLD, DETECT and DELAY to minimum (fully anticlockwise).
- 9 On the PHDA move the recorder output switch down to "Peak".
- 10 Zero the PHDA using the "OFFSET" control while monitoring the digital display (the OFFSET switch must be ON, to the right).
- 11 Slowly turn up the stimulation amplitude until the oscilloscope shows a supramaximal evoked signal.
- 12 Adjust the delay time "DELAY" (DY) so that the stimulation artefact or other fast interference signals are suppressed (see Fig. 4). During this adjustment monitor the two traces on the oscilloscope.
- 13 Now increase the detection time "DETECT" (DT) until the desired peak value of the signal curve is captured by the peak value buffer (see Fig. 4). The lower oscillograph beam (Y2) indicates the acceptance window of the peak height detector.
- 14 Now switch on the recorder (if used), adjust its sensitivity to 10 V for the full recording width and the chart speed to 1 cm/min. Adjust the pen zero with the "POSITION" control.
- 15 Next increase the hold time on the PHDA with the "HOLD" control until the recorder shows maximum deflections (see Fig. 4).

- 16 For estimating the measured peak-amplitude in a simple way, set the digital voltmeter [OUTPUT DC (V)] to 1.00 V, using the "OFFSET" control.
- 17 Move the output selector switch to "PEAK + DC" in order to record the combined curve of peak amplitude plus d.c. potential difference. The jump in the amplitude of the recorded curve is equal to the set DC-voltage of 1 Volt. Comparing the amplitudes you can now estimate the peak voltage. Dividing the peak amplitude by the selected amplification you will get the real peak-amplitude at the electrodes. If you want to record the actual d.c. potential at the electrodes you have to cut out the effect of the "OFFSET" control using the switch. The indicated voltage (Volt) divided by the selected amplification (gain) then gives the input voltage.

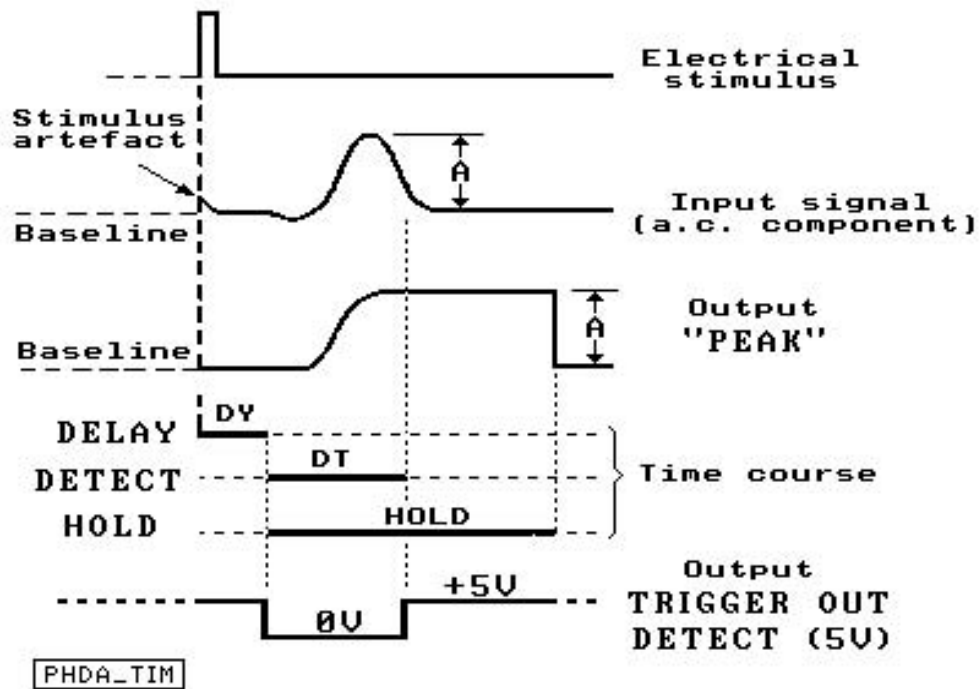


Fig. 4: Time course during capture of the peak amplitudes. Note: negative signals are not recorded.

7. Block diagram of the Peak Height Detector Amplifier PHDA

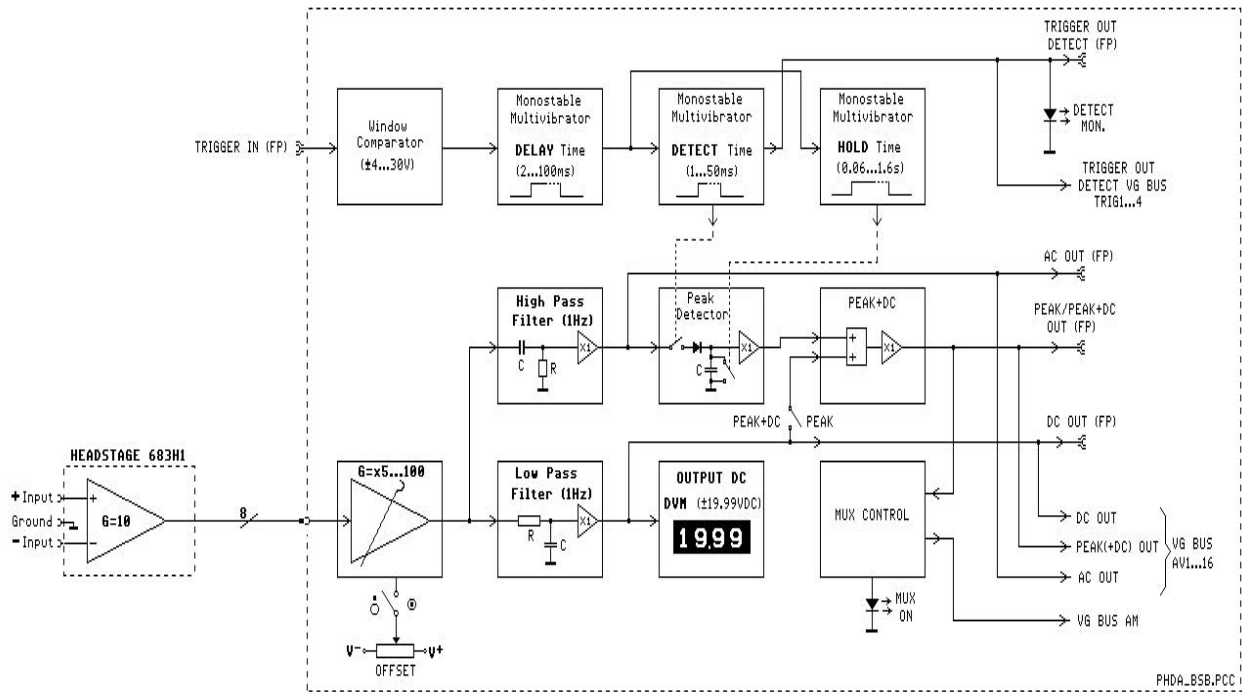


Fig. 5: Block diagram of the Peak Height Detector Amplifier PHDA

8. Description of the controls

Note: in the description below the numbers after the full stop correspond to the item numbers in Fig. 6.

8.1 INPUT FROM HEADSTAGE

Socket to connect up the preamplifier box "HEADSTAGE 683H1" (for pin connections see under Technical Data).

8.2 OFFSET <-->

Control for zeroing the input voltage. The adjustment range is about ±80 mV referred to the preamplifier input. Zero adjustment is effective only when it is switched in with the switch (3) (toggle to the right).

8.3 OFFSET ON/OFF

Switch to cut out the zero adjustment (2). Toggle right = ON, toggle left = OFF.

8.4 GAIN and LEDs: 50 - 100 - 200 - 500 - 1000

Control for setting the desired gain: 50, 100, 200, 500, 1000. The green LED corresponding to the selected value lights up. The value refers to the complete signal path from the input of the preamplifier (HEADSTAGE 683H1) up to the output. (Gain of the headstage preamplifier: 10x).

8.5 MUX key and LED

Brief pressure on the key switches the output voltage (PEAK or PEAK + DC) to a digital voltmeter module (DVM Type 666). This facility is available only if a DVM module is installed in the PLUGSYS housing.

Note: the function of the MUX key is not available if the PHDA is installed in a small housing without system bus (PLUGSYS housing Type 607).

8.6 Digital voltmeter OUTPUT DC (V)

Digital voltmeter to indicate the amplified d.c. voltage. Indication range: 19.99 Volt. Resolution: 10 mV

8.7 TRIGGER IN (4-30 V)

Input (BNC socket) to trigger the peak detector circuit. Permitted trigger voltage: 4...30 Volt. Input impedance: 5 kΩ. The trigger circuit responds to a pulse slope towards 0 Volt (starting from + or -4...30V). The switching point is at 2.5 V input voltage.

8.8 DETECT (DT 1 - 50 msec)

This control selects the duration of the active time for the peak detector circuit (c.f. Fig. 5). Adjustment range: 1 to 50 msec. Its adjustment is monitored on an oscilloscope so that the desired amplitude peak of the signal voltage is captured by the detector (cf. Fig. 3).

8.9 TRIGGER OUT DETECT (5 V)

Trigger output (BNC socket) to check the detector time setting. While the detector is activated the voltage jumps from +5 Volt to 0 V (see Fig. 5). This signal can be monitored on the second channel of the oscilloscope in parallel with the a.c. signal. This signal can also be used to control the Z modulation (= brightness modulation) of the oscilloscope. The input for Z modulation is usually at the back of the oscilloscope.

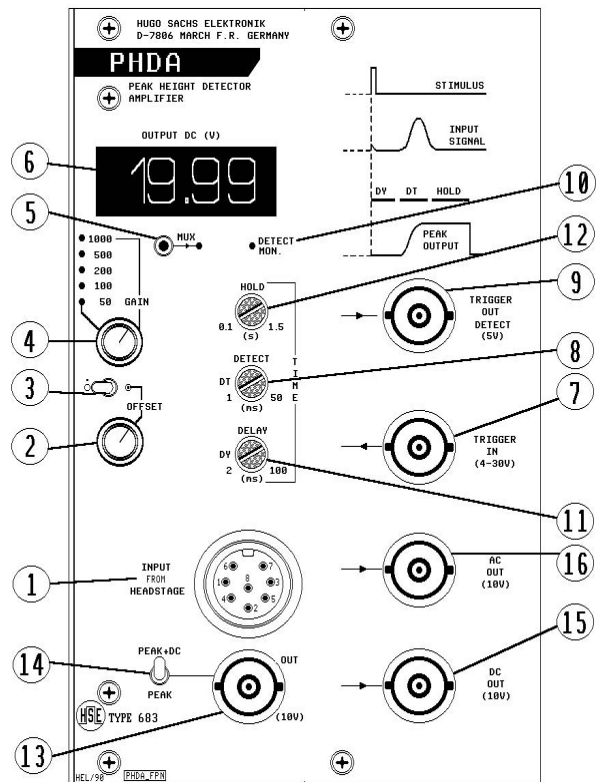


Fig. 6: Controls and indications on the front panel. For explanations of the item numbers see text.

8.10 DETECT MON. (LED)

This LED is connected in parallel to the trigger output (9) and permits simple and rapid monitoring of the trigger function.

8.11 DELAY (DY 2 - 100 msec)

This control adjusts the delay time between trigger signal at the trigger input (7) and the start of the detect time (see Fig. 5). Adjustment range: 2 to 100 msec. The delay is normally selected so that interference from stimulus artefacts or uninteresting rapid components of nerve impulses are cut off.

8.12 HOLD (0.1 - 1.5 sec)

This control determines the hold time of the peak store. The hold time has to be so adjusted that the recorder used records correct amplitudes and that overlapping with the stimulation frequency is avoided (see Fig. 5).

The speed of the recorder pen movement is limited by the limiting frequency (f_g) of the particular recorder. The time constant (T) for the movement of the recorder pen can be calculated from:

$$T \text{ (sec)} = 1/[f_g \text{ (Hz)}]$$

It is normally advisable to set the hold time to at least $10 \cdot T$. In any case the hold time should be set so that the pen at least reaches full deflection and settles there before it returns to the zero line.

When using a fast pen recorder (e.g. GRAPHTEC Mark VII or Mark VIII) a shorter time (0.1 - 0.3 sec) may be adequate. For a "slower" potentiometric recorder (e.g. MULTICORDER) a longer time to suit the slower response has to be selected (0.3 - 1.5sec).

8.13 OUTPUT PEAK / PEAK+DC (10 V)

The signal at this output (BNC socket) can be selected with the switch (14) between the pure peak amplitude determined by the peak height detector, and the sum of peak amplitude plus d.c. voltage. A recorder connected at this output shows the d.c. signal as a slowly varying baseline (= d.c. signal) with superimposed spikes (= PEAK signal) if the switch (14) is set to PEAK+DC. This provides a very good representation of drug-induced fluctuations in membrane potential together with evoked rapid potentials on a single recording trace.

When using a 2-channel recorder PEAK and DC signal can be shown separately. Switch (14) is then set to PEAK and the d.c. signal is taken separately from the output socket (15).

8.14 PEAK <--> PEAK+DC

Switch to select the signal at the output socket OUT (10 V), see under 7.13.

8.15 DC OUT (10V)

This output (BNC socket) carries the d.c. signal. The d.c. signal is also shown on the built-in digital voltmeter.

The d.c. signal circuit incorporates a low-pass filter with 0.3 Hz limiting frequency. This output therefore carries only slow signals (membrane potentials) within the frequency range from 0 (= d.c.) to 0.3 Hz. More rapid components of the signal are filtered out.

8.16 AC OUT (10 V)

Signal output (BNC socket) for fast evoked potentials after amplification, for connection to an oscilloscope. This signal can be used in connection with signal (9) [TRIGGER OUT DETECT (5 V)] to monitor the actual region of the trace in which the peak height detector is activated. One channel of the oscilloscope shows the a.c. signal and the other channel the signal "TRIGGER OUT DETECT".

In order to obtain a stable baseline the amplifier circuit for the a.c. signal incorporates a high-pass filter. The bandwidth of the a.c. signal circuit is about 1.5 Hz to 40 kHz (Fig. 7).

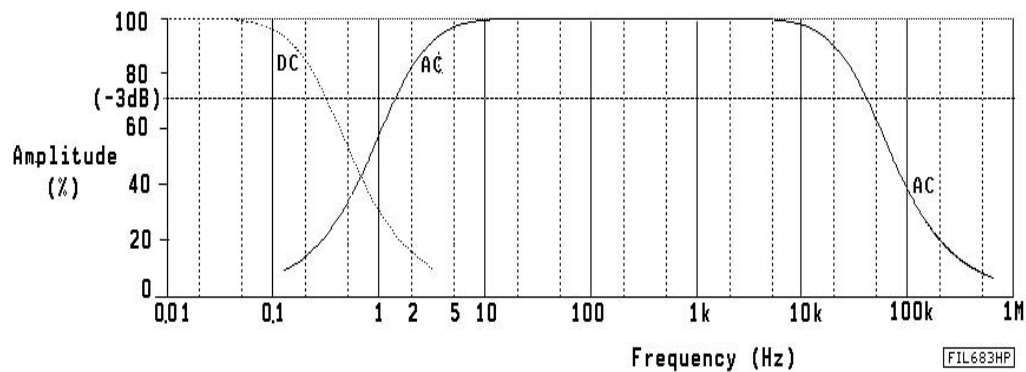


Fig. 7: Frequency response of the AC and DC signal circuits.

9. Installing the module in a housing, setting the signal paths

For operation the module has to be installed in an HSE PLUGSYS Series 600 housing. The housing provides the necessary and correct power supply for the module.

9.1 Independent PHDA, single-channel amplifier

If the PHDA is to be operated as an independent single-channel unit it can be fitted into a narrow Type 607 housing. This housing Type 607 contains, in addition to the power supply, only a connector to take one module. Signal inputs and outputs can therefore not be taken through the module connector but only through the front panel of the module. This in turn requires that the PHDA version with the wide front panel is selected (see Section 4 and Fig. 2).

9.2 PHDA in bus housing, multi-channel or together with other modules

In all cases where this module is employed in a multi-channel system or together with other PLUGSYS modules a standard HSE PLUGSYS housing fitted with bus backplane has to be used (Type 600...603). In this operating mode all the trigger and output signals (except the "PEAK+DC" signal) can be passed over the system bus. The bus lines used have to be determined with due regard to the other modules before installation. In particular it is essential to avoid any duplication, i.e. only the output signal of a single module may be connected to a particular bus line, otherwise the amplifier outputs work in opposition to each other, leading to completely false signals and overloading the electronic components.

This point applies to the analogue signal outputs (AC, DC and PEAK). Conditions in the case of the trigger signals are different. All trigger outputs are arranged as open collector circuits so that they can readily be connected in parallel without any danger to electronic components, where this is required by the measurement sequence.

In accordance with the above considerations it is possible to fit a housing with system bus either with the PHDA in the narrow front plate version or with one with the wider front panel. In the latter case all signals are taken out to BNC sockets on the front panel. They can also be led via the system bus by setting the appropriate jumpers. In the narrow version only the PEAK/PEAK+DC output signal is available on the front panel; the other signals can be taken out via the system bus.

9.2.1 Determine the signal paths

As mentioned above, before the PHDA is installed in a standard HSE PLUGSYS housing with built-in system bus (Type 600...603) the paths for the various signals have to be determined through jumpers on the PHDA circuit board. Table 1 lists the various possibilities in relation to the housing (with or without system bus) and depending on the front panel width.

Use the block diagram (Fig. 5) and the circuit board drawing (Fig. 8) and decide on the connections in accordance with your requirements. Do not forget to enter the selected connections afterwards into the appropriate bus diagram. The bus diagram can be found in the Manual of the PLUGSYS housing under the heading "Operating Instructions for Housing (usually item 1)

The PHDA can operate as intended only if the jumpers have been set correctly. The timing control of the peak detector can only be activated at the correct instant if the trigger input receives a correct signal in synchronism with the stimulus. It is therefore important that, in addition to the measurement signal paths, the trigger input receives correct signals.

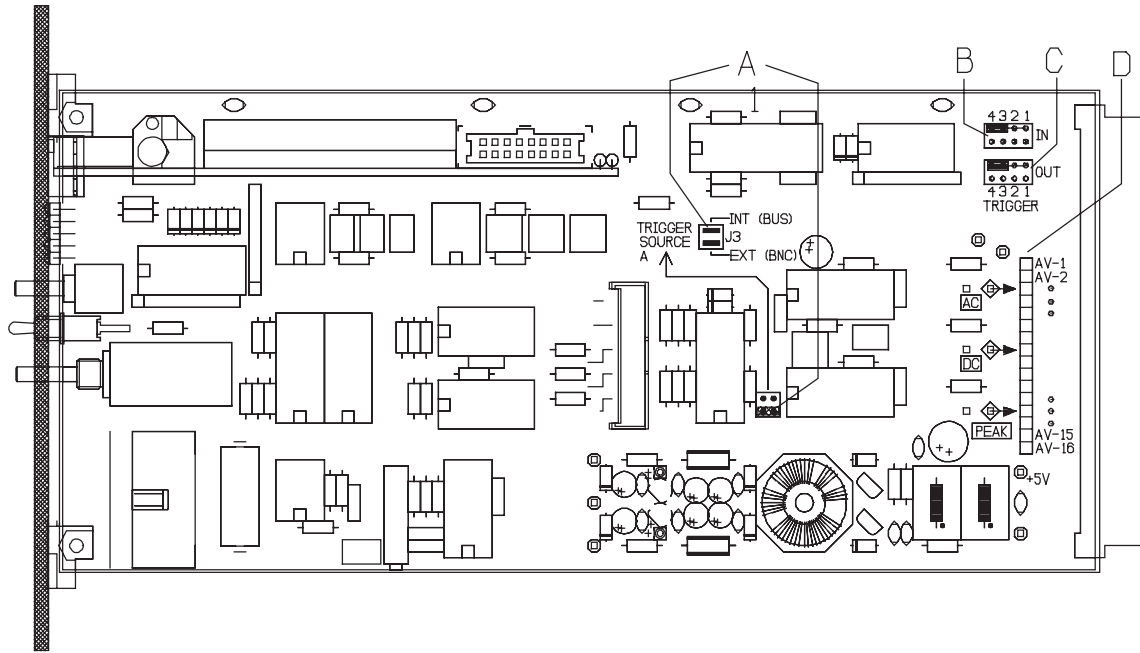


Fig. 8: View of circuit board of the PHDA. Before installing the module in the housing the links A...D have to be determined. Note details in the text!

| Ref.in Fig. 8 | Signal description, notes | PHDA with wide front panel. Housing without bus (607) | PHDA narrow front panel. Housing with bus (600...603) | PHDA, wide front panel. Housing with bus (600...603) |
|---------------|--|--|---|--|
| A | Source for trigger signal for the timing of the peak height detector: externally, BNC plug on front panel, or internally through system bus. | Place jumper on bottom pins. | Place jumper at the top. | Place jumper at the bottom (select top jumper only if a PSM module is also being used). |
| B | TRIGGER IN (4...30V) Trigger signal (input) for timing control of the peak height detector. | Place jumper on parking position shown (use top pins!) | Place jumper on TR IN 1...4 | Without PSM (see above) place jumper in parking position shown, otherwise TR IN 1...4 |
| C | TRIGGER OUT DETECT (5V) Trigger signal (output) for monitoring the selected "detection window" on the oscilloscope. | Place jumper on parking position shown (use top pins!) | Place jumper on TR OUT 1...4 | Place jumper in parking position shown. When using bus: TR OUT 1...4 |
| D | Analogue output signal of the PHDA: AC, DC, PEAK (identical with the corresponding signal on the BNC sockets on the front panel). | Jumper connections in parking position (pins NC) | Place jumper connections in agreement with the other modules on AV1 to AV 16. | When using bus select AV 1 to AV 16 in agreement with the other modules. Otherwise in parking position (pins NC) |

10. CE 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.

11. Technical data

11.1 HEADSTAGE (683H1) preamplifier:

| | |
|--------------------------------------|--|
| Input | differential input |
| Input sockets | +input, - input and null, spring-loaded sockets suitable for solid 2 mm plugs |
| Input impedance | >1012 Ohm |
| Input capacity | approx. 20 pF |
| Input bias current | >50 pA (typically 10 pA) |
| Gain | 10x (headstage only) |
| Noise | 40 microvolt peak-to-peak, input short-circuited |
| Permitted differential input voltage | +/- 0.2 V max. |
| Permitted common mode voltage | +/-8 V d.c. |
| Common mode rejection | >100 000:1 (>120 db) at UE = 1 V, 50-60 Hz |
| Oversvoltage protection | +/- 15 V continuous, 100 V non-repetitive spike |
| Connecting cable | L = 2.2 m, 8-pin BINDER circular connector |
| Dimensions | 20 mm x 26 mm x 50 mm, support rod (l = 155 mm, D = 8 mm) can be unscrewed. |

11.2 Module PHDA (683):

| | |
|---------------------------------------|--|
| Input | single-sided input |
| Input socket | Binder circular connector, 8-pin (for pin connections see below) |
| Input impedance | 1500 Ohm |
| Selectable gain | 50/100/200/500/1000 (with headstage) |
| Input zero adjustment OFFSET | ±80 mV with 10-turn potentiometer, can be switched off |
| Frequency response a.c. path | 1.5 Hz ... 40 kHz (- 3dB) |
| d.c. path | 0 - 0.2 Hz (-3 dB) (time constant T= 1 sec) |
| Range of digital voltmeter | ±19.99 V d.c. |
| Trigger input TRIGGER IN | ±4...30 V, input impedance: 5 kOhm |
| All analogue outputs (PEAK+DC, AC, DC | ±10 V (12 V _{max}), 10 mA _{max} |
| Trigger output TRIGGER OUT DETECT | 5 V (active low = 0 V, open collector output, R _{pull up} = 2.2 kOhm) |
| Supply via bus connector | 5 V, 0.7 A |
| Bus connector | DIN 41612, 96-pin VG connector |

Pin connections of input connector:

- (1) not used
- (2) null (analogue null)
- (3) input (1.5 kOhm)
- (4) not used
- (5) not used
- (6) supply +15 V (20 mA_{max})
- (7) supply -15 V (20 mA_{max})
- (8) not used

case = ground

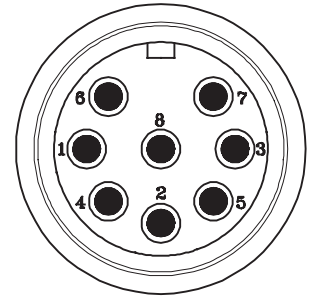


Fig. 10: Input socket
(seen from the front)

11.3 Mechanical data:

| | |
|---------------------|-------------------------------|
| Dimensions | module for 19 inch rack |
| Front panel (H x W) | 127.5 mm (3 U) x 40.5 mm (8E) |
| Circuit board | Europa size (100 x 220 mm) |
| Weight | 0.5 kg |

12. appendix: different figures

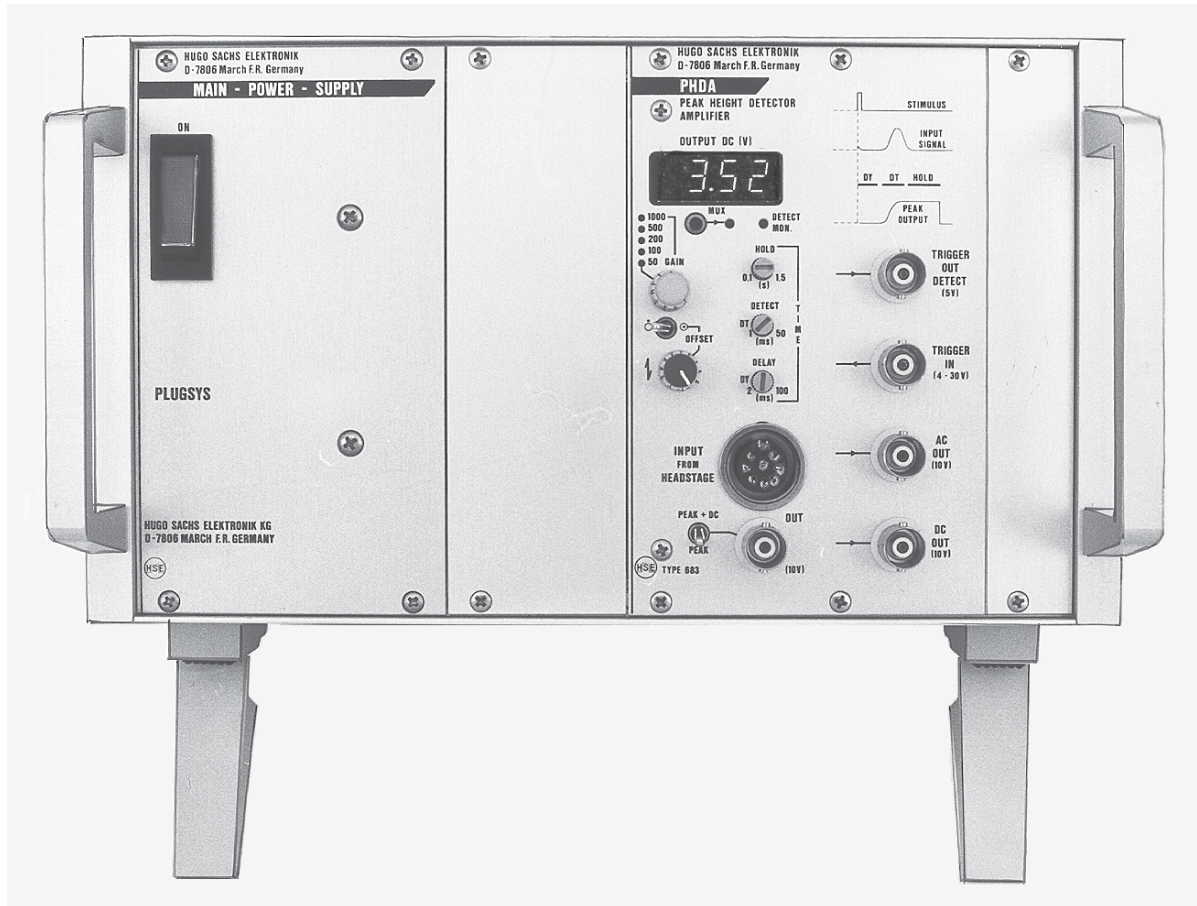


Fig. 11: Peak Height Detector built in an PLUGSYS case Type 607

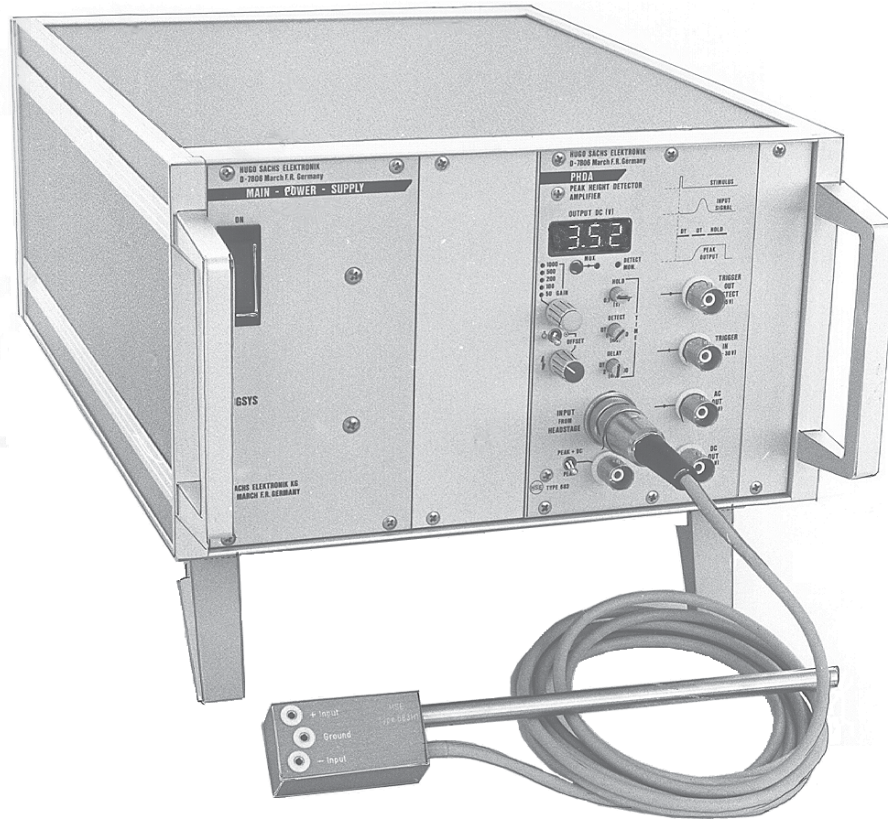


Fig. 12: PHDA type 683 built in a PLUGSYS case type 607 headstage preamplifier 683 H1 connected