Operating Instructions

for the

PLUGSYS® Module

EMGA Electromyogram Amplifier Type 691

(Version: 1.1 / Print date: April 14, 2011 from Ser.No. 95001 / T. Beha)

Contents **Page**

1. Introduction, manufacturer's information

These Operating Instructions describe the function and the use of the **EMGA** module Type 691. 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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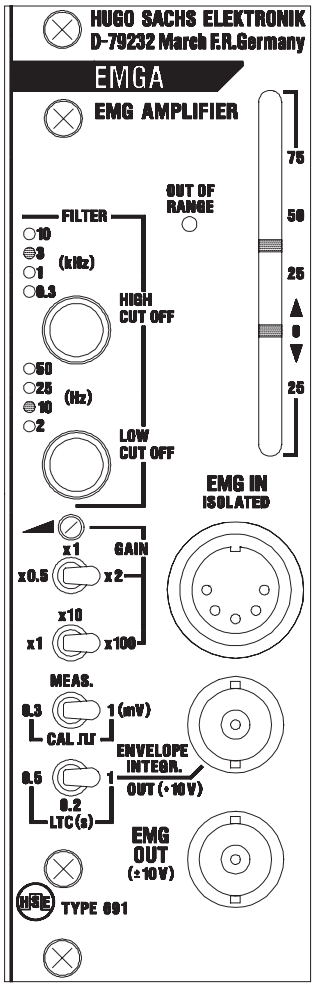
2. Safety note

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

3. General description, application



The **EMGA** module Type 691 is a module for the HSE PLUGSYS measurement system and serves for measuring and amplifying EMG 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 EMG signals with frequencies up to 10kHz.

The EMG 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 EMG amplitudes.

Before the **EMGA** 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 **EMGA** module it has to be installed in a suitable HSE PLUGSYS housing Series 600 (Dez. 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 **EMGA** module.
- Prepare the module according to Section 4 (set lines and links).
- Insert the **EMGA** module, note the guide rails.
- Push the module firmly into the bus connector.
- Screw on the front panel.
- Plug in the EMG cable.
- Reconnect the mains plug to the housing.
- Switch on the housing.

4.1 Internal instrument settings, links

Warning: the **EMGA** module must be protected against electrostatic discharges while it is outside the housing!
The **EMGA** 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 **EMGA** 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 links have to be set:

Signal output for EMG to PLUGSYS bus system
Signal output for Envelope Integration to PLUGSYS bus system

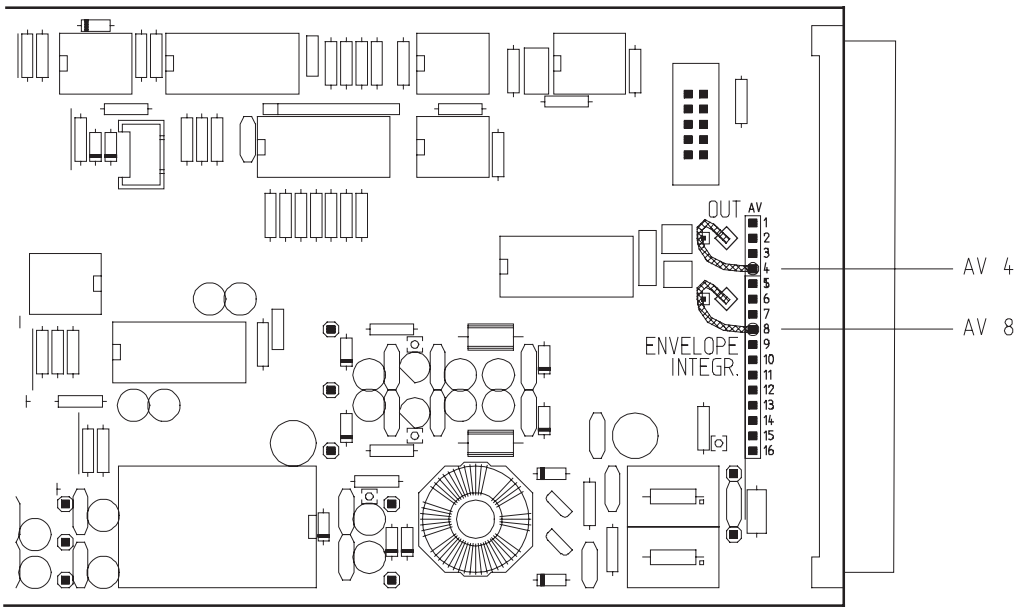


Fig. 2: Position of the internal links

In the example shown above the EMG signal output has been set so that the analogue EMG signal is on bus line AV 4. The Envelope Integration signal is on bus line AV 8

5. Starting up

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

5.1 Arranging an EMG signal on the recording chart, calibration

The **EMGA** 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 10 kHz.

(D) Set filter **"LOW CUT OFF"** to 2 Hz.

(E) Set **"GAIN"** switch to **"x1"** and switch **"x1/x10/x100"** to **"x10"**.

(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. Set gain so that bargraph shows a deflection of about 75%

(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 EMG. 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 EMG 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 EMG.

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 EMG 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 EMG 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 2 Hz filter setting.

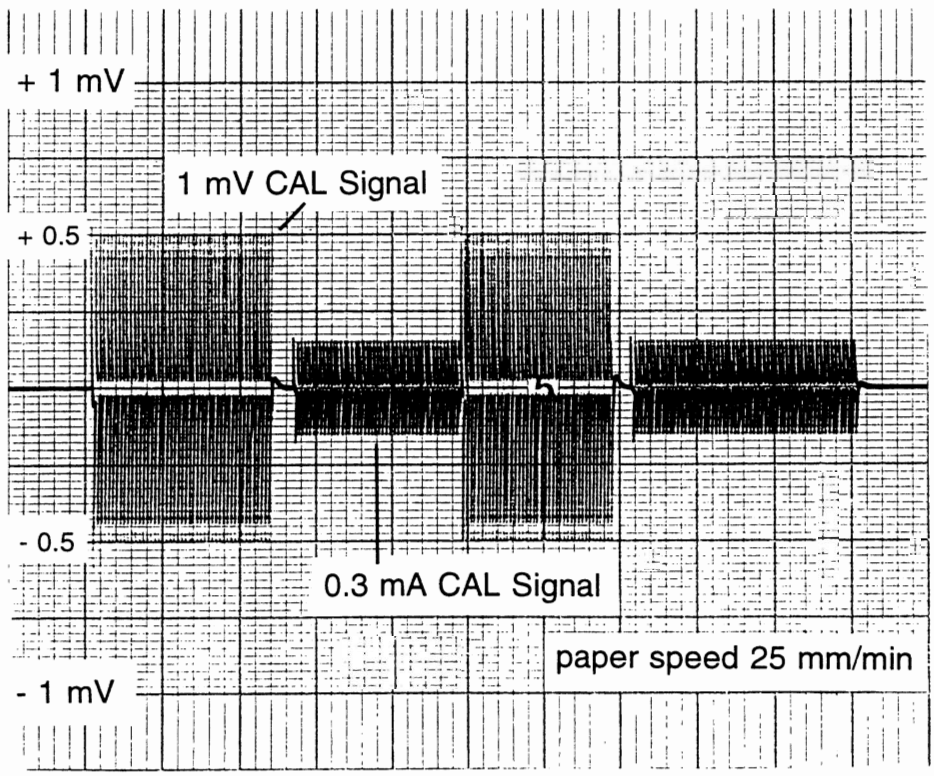


Fig. 3: Setting up an EMG scale on the chart, selected range ±1 mV, see text above.

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 10 kHz.

(D) Set filter **"LOW CUT OFF"** to 2 Hz.

(E) Set **"GAIN"** switch to **"x1"** and switch **"x1/x10/x100"** to **"x10"**.

(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 EMG. 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 EMG 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 EMG.

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 EMG 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 EMG 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 2 Hz filter setting.

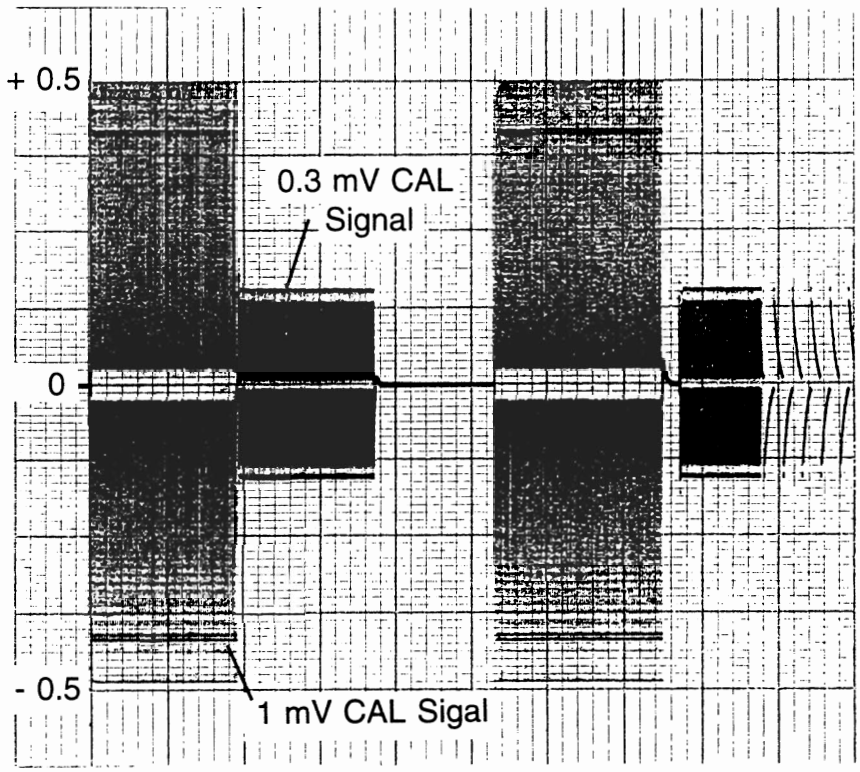


Fig. 4: Setting up an EMG scale on the chart, selected range ±0.5 mV, see text above.

5.2 Chart-Example with EMG Signal and Envelope Integration Signal

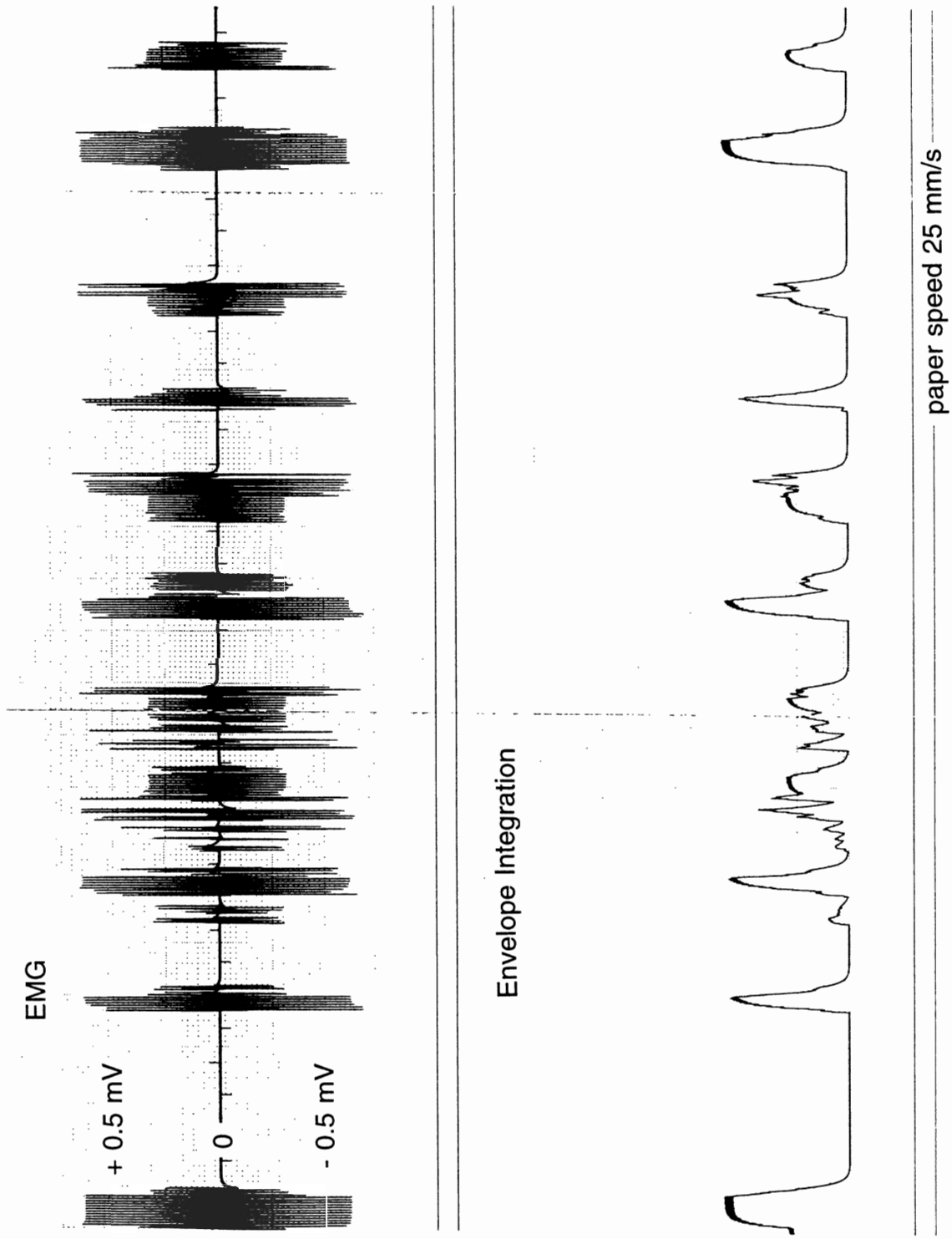


Fig.5: Chart example channel 1 (top) EMG Signal, channel 2 (bootom) Envelope Integration Signal
Settings on EMGA: HIGH CUT OFF 10kHz, LOW CUT OFF 10 Hz
Leakage Time Constant LTC = 0.5s

5.3 Envelope Integration Signal with different settings of LTC switch

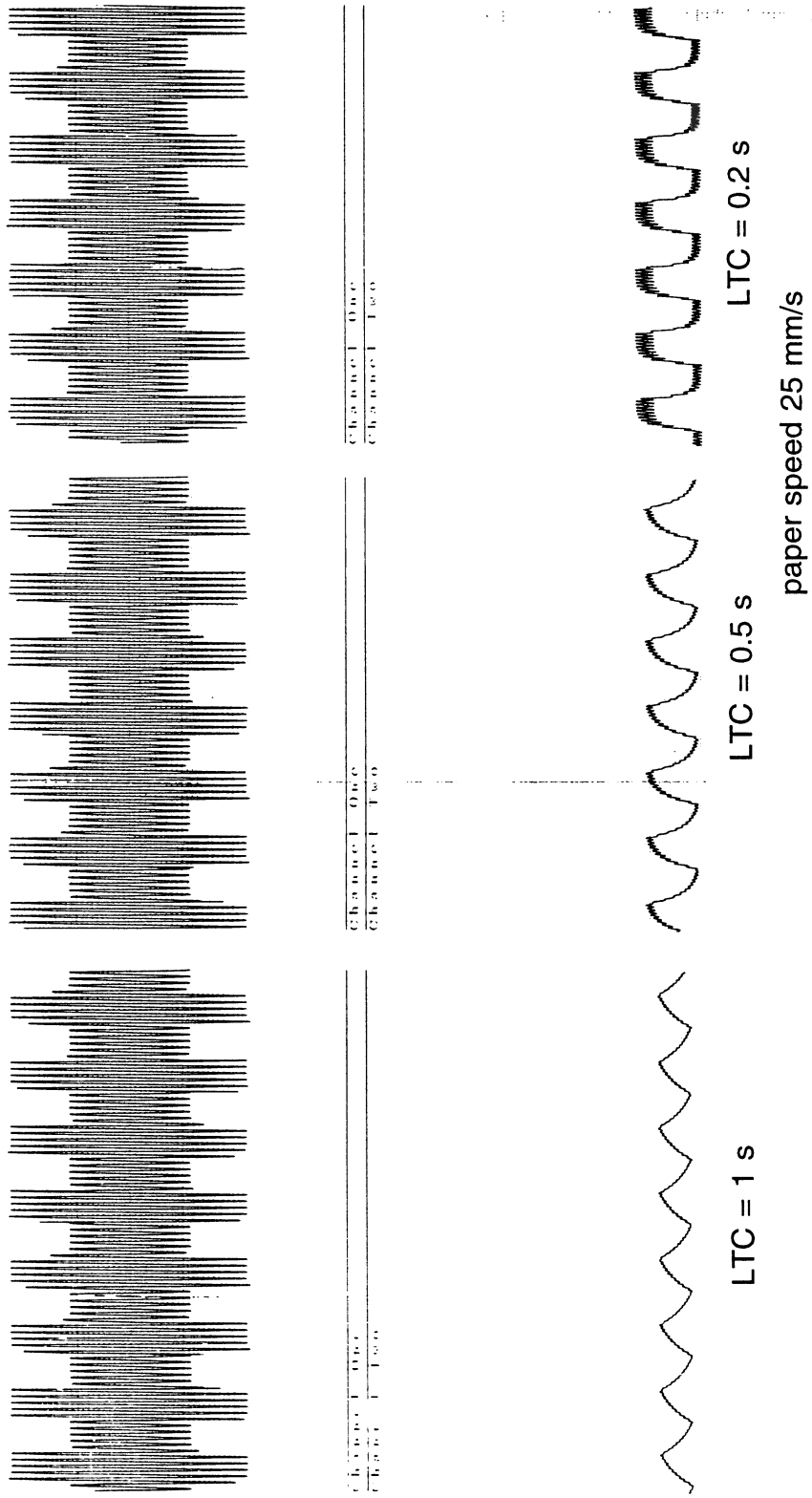


Fig.6: Chart example channel 1 (top) EMG signal, channel 2 (bottom) Envelope Integration Signal
Einstellungen: HIGH CUT OFF 10kHz, LOW CUT OFF 10 Hz

6. Input pin connections

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

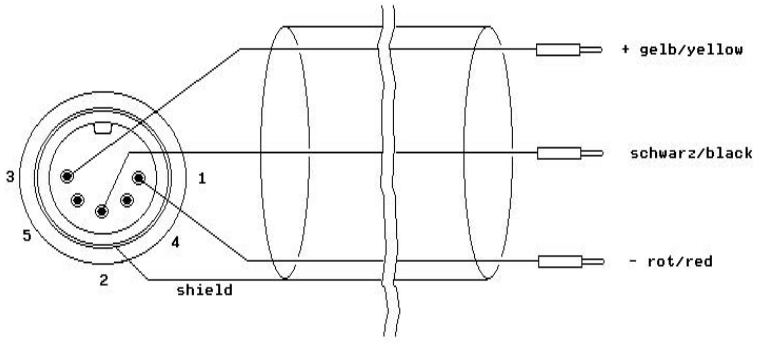
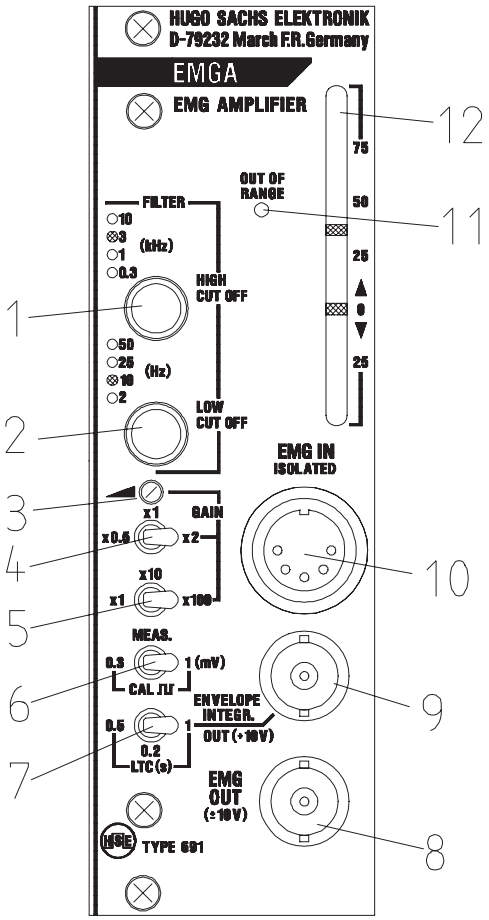


Fig. 5: Input socket for 3-pin plug

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 10 kHz, then switching down to 3 kHz and noting the amplitude. The amplitude should not be reduced, otherwise filtering is already too strong.

(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).

(3) This is a fine adjustment of the amplification (GAIN) using a screwdriver. If the amplitude of the EMG signal is too large it can be reduced here. This fine adjustment is always linked to the switches **"x0.5/x1/x2"** and **"x1/x10/x100"**. 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. Switch **"x1/x10/x100"** is used to set the coarse gain in steps of 10.

(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 **"x1/x10/x100"** is used to set the coarse gain in steps of 10.

(6) 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 EMG signal.

(7) switch LTC (leakage time constant) for Envelope Integration. This switch is used to select between three leakage time constants for Envelope Integration.
Envelope Integration means: the EMG signal is rectified, so that the negative wafes appeare on the positive side. This signal is Integrated with one of the time constants. The maxima of the integration signal results in the Envelope Signal.

(8) BNC socket EMG 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.

(9) BNC socket ENVELOPE INTEGRATION OUT (±10 V). This socket carries the Envelope Integration signal in the voltage range +10 V. This socket can be used for connection to a recorder or oscilloscope.

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

(11) 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, at the switch **"x0.5/x1/x2"**, or **"x1/x10/x100"**

(10) LED bargraph to visualise the EMG signal.

8. Faults, their causes and remedies

- LED **"OUT OF RANGE"** flashing
Amplification (GAIN) too high, EMG amplifier overloaded

Remedy: Reduce amplification. Turn switch **"x0.5/x1/x2"** or **"x1/x10/x100"** into a lower position **"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. Recalibrate amplitude.

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

Remedy: Increase amplification. Move switch **"x0.5/x1/x2"** to position **"x1"**, move switch **"x1/x10/x100"** 10 times higher. 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%.

- EMG signal not particularly pronounced. Possibly excessive filtering.

Remedy: Move filter **"HIGH CUT OFF"** to 10 kHz and check recorder. Perhaps switch down to 3kHz. Amplitude 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"**.

9. Maintenance and cleaning

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

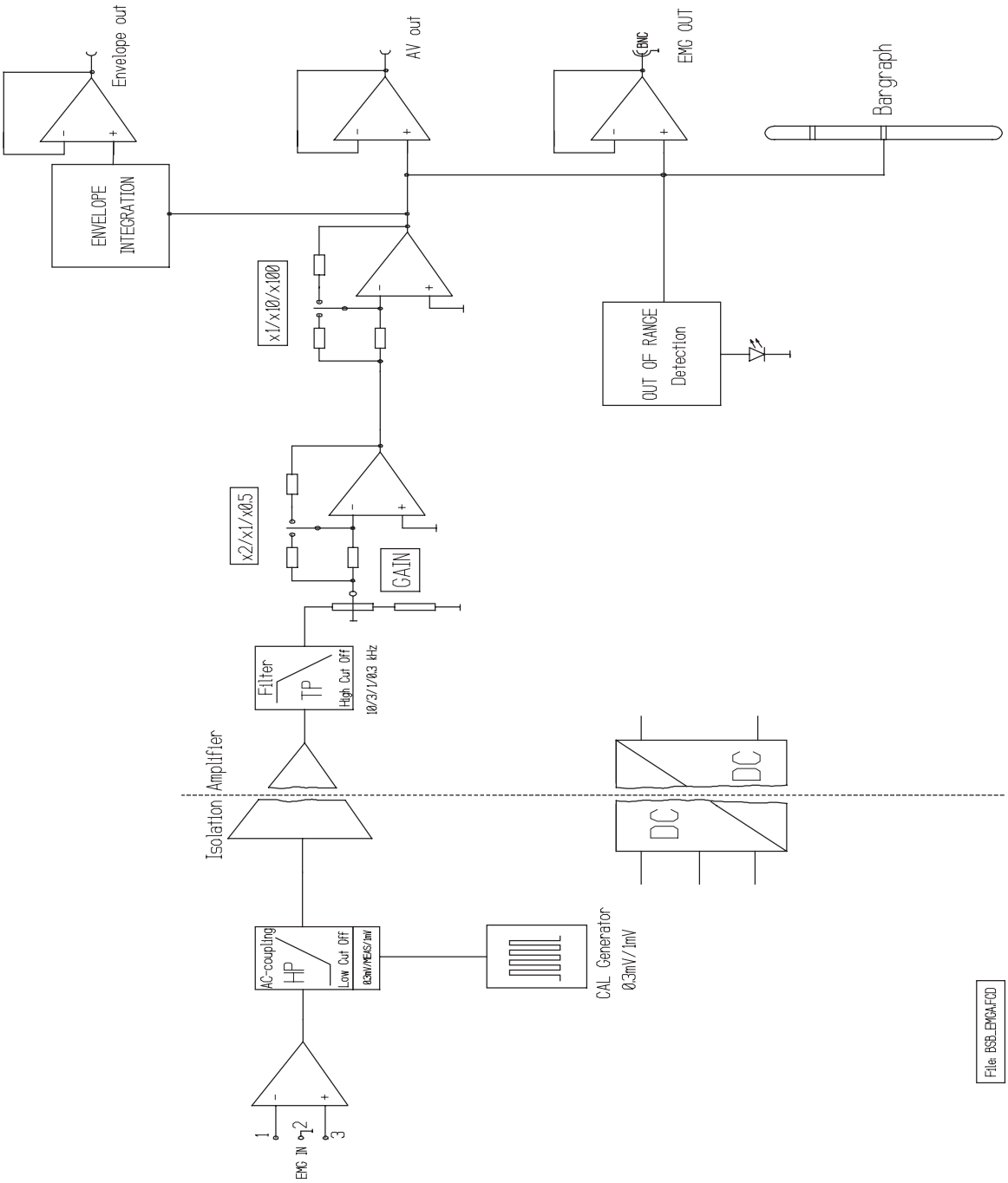
The front panel can be cleaned if necessary with a lightly moistened (not a wet) cloth. Before cleaning always pull out the mains supply plug!

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 EMGA 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 10 kHz, 3 kHz, 1 kHz, 0.3 kHz
high-pass filter 50 Hz, 25 Hz, 10 Hz, 2 Hz

Amplification: **"GAIN"** trimmer fully clockwise

switch	x1	x10	x100
position x0.5	500	5000	50000
position x1	1000	10000	100000
position x2	2000	20000	200000

"GAIN" trimmer fully anticlockwise

switch	x1	x10	x100
position x0.5	100	1000	10000
position x1	200	2000	20000
position x2	400	4000	40000

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 EMG 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:	EMG input cable, BNC output cable, Operating Instructions