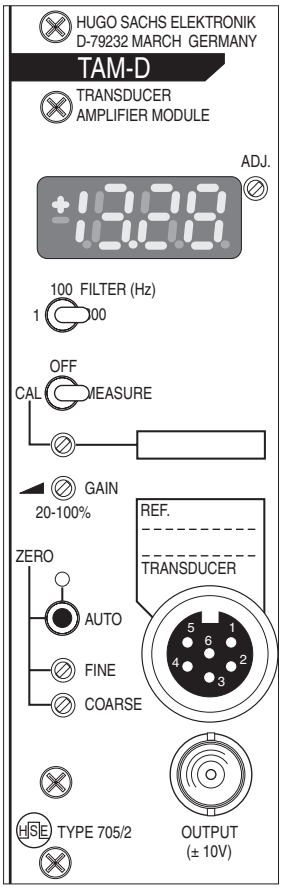
OPERATING INSTRUCTIONS

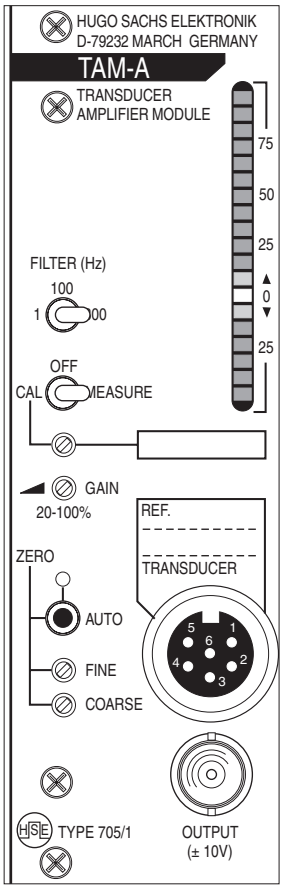
for the

PLUGSYS® Module
Transducer Amplifier Module TAM

Version TAM-A Type 705/1 with bargraph display
Version TAM-D Type 705/2 with digital display

(Version 1.4 / printet: June 2013 / Hellstab / TB / Zi)





NOT FOR HUMAN USE

Contents

1 Introduction, manufacturer's details

These Operating Instructions describe the function and use of the TAM-A Module Type 705/1 and the TAM-D Module Type 705/2. They are part of the plug-in module and have to be kept close to it. The information provided on the TAM has to be read in conjunction with the remaining system documentation of the PLUGSYS housing.

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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1.2 Trademark

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2 Safety note

Warning:

the equipment is designed for use in general laboratories, light industrial and office environments. Operation in hazardous areas and/or in a flammable atmosphere is not permitted.

March-Hugstetten, June 2008

3 General description, application

☞ The transducer amplifier module TAM is equipped, depending on the version, either with analogue (TAM-A) or digital (TAM-D) display. Apart from a few exceptions, the amplifiers of the two versions are identical. In the description below, the symbol TAM refers to both module versions. The symbol TAM-A or TAM-D is used when referring to the different properties of the two amplifier variants.

The amplifier module TAM is a univeral DC bridge amplifier. In conjunction with a suitable resistive transducer it permits direct measurement of e.g. force, pressure or displacement. The amplifier is arranged as a plug-in module of the PLUGSYS measuring system and is operated inside a PLUGSYS housing.

TAM-A (Type 705/1) is equipped with a LED line, a so-called bargraph. Visual analogue presentation of the measured signal, is ideally suitable for monitoring dynamic signals.

TAM-D (Type 705/2) carries a 3½-digit LED display. It is therefore particularly suitable for evaluating static signals. The instantaneous measurement can be read directly on the numerical display of the TAM-D. By calibrating the module to the transducer it is possible to adjust the sensitivity of the display so that the measurement can be read off directly (e.g. force in ±100 mN, pressure in ±200 mm Hg, displacement in ±4 mm etc.).

The amplification (Gain) of the TAM can be adjusted over a very wide range (x2 to x10 000) to suit the requirements of the transducer. The DC supply (excitation voltage) for the transducer is fixed at 5 V, the value commonly employed today.

As a special feature, both amplifiers TAM-A and TAM-B are equipped with automatic zeroing in addition to manual zero adjustment.

In order to have an easy calibration of a connected data acqusistion system a predefinded value eg. 10mN, 100mmHg or 5mm can be simulated on the output.

The output filter 30-100-300 Hz is used for smoothing the signal. It acts on both signal outputs PULSE (internal) and BNC socket (front panel). The internal signal output MEAN is preceded by a low-pass filter of 0.1 or 0.3 Hz. As an option the MEAN output can be connected to the BNC socket on the front panel through an internal jumper on the circuit board.

4 Installing the module in a housing

The TAM module is designed as a PLUGSYS module and has a width of 8E corresponding to two slots. It can be installed directly in any housing with a system bus. An exception is the PLUGSYS MiniCase Type 609; the TAM can also be operated in this housing but installation requires some soldered connections and it is therefore only supplied completely installed from the factory.
If you bought your module installed in a housing these adjustments already have been made in the factory prior to shipping.

4.1 Installation procedure

Before the module is installed in a housing it is necessary to make a number of internal adjustments. First it is necessary to carry out the adjustments described in Section 4.2. Note the precautions described in Section 4.2.1 which are absolutely essential in order to avoid electrostatic discharges.

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

- ❑ Switch off the housing and pull out the mains plug.
- ❑ Remove the blank panel at the housing slot position intended for the TAM module.
- ❑ Make the internal adjustments according to Section 4.2.
- ❑ Insert the TAM module, note the guide rails.
- ❑ Firmly push in the module, it must clearly engage with the bus connector.
- ❑ Screw on the front panel, reconnect the mains cable to the housing, and plug in the transducer.

4.2 Internal settings, jumpers

In order to adjust the TAM to the individual application the following settings have to be made with jumpers on the module circuit board. See diagrams next page !

- ❏ Jumper J1 (TAM-D only): position of decimal point on the digital display
- ❏ Jumper J2: gain of the input amplifier GAIN x1 - x1000 (the overall gain is 10x higher due to the subsequent output amplifier)
- ❏ Jumper J3: time constant for the MEAN output 0.1 or 0.3 Hz
- ❏ Jumper J4: PULSE or MEAN output at the BNC socket on the front panel
- ❏ Jumper J5: bus lines AV1 - 16 for the internal signal outputs PULSE and MEAN
- ❏ Jumper J6: (TAM-D only) input filter of digital display SLOW - FAST
- ❏ Jumper J7: input selection between transducer with resistance bridge circuit (POS.2) or voltage input from transducer with integrated amplifier (POS.1)
- ❏ Jumper J8: to adjust the calibration range of the autozero to the selected amplification and the internal resistance of the transducer.

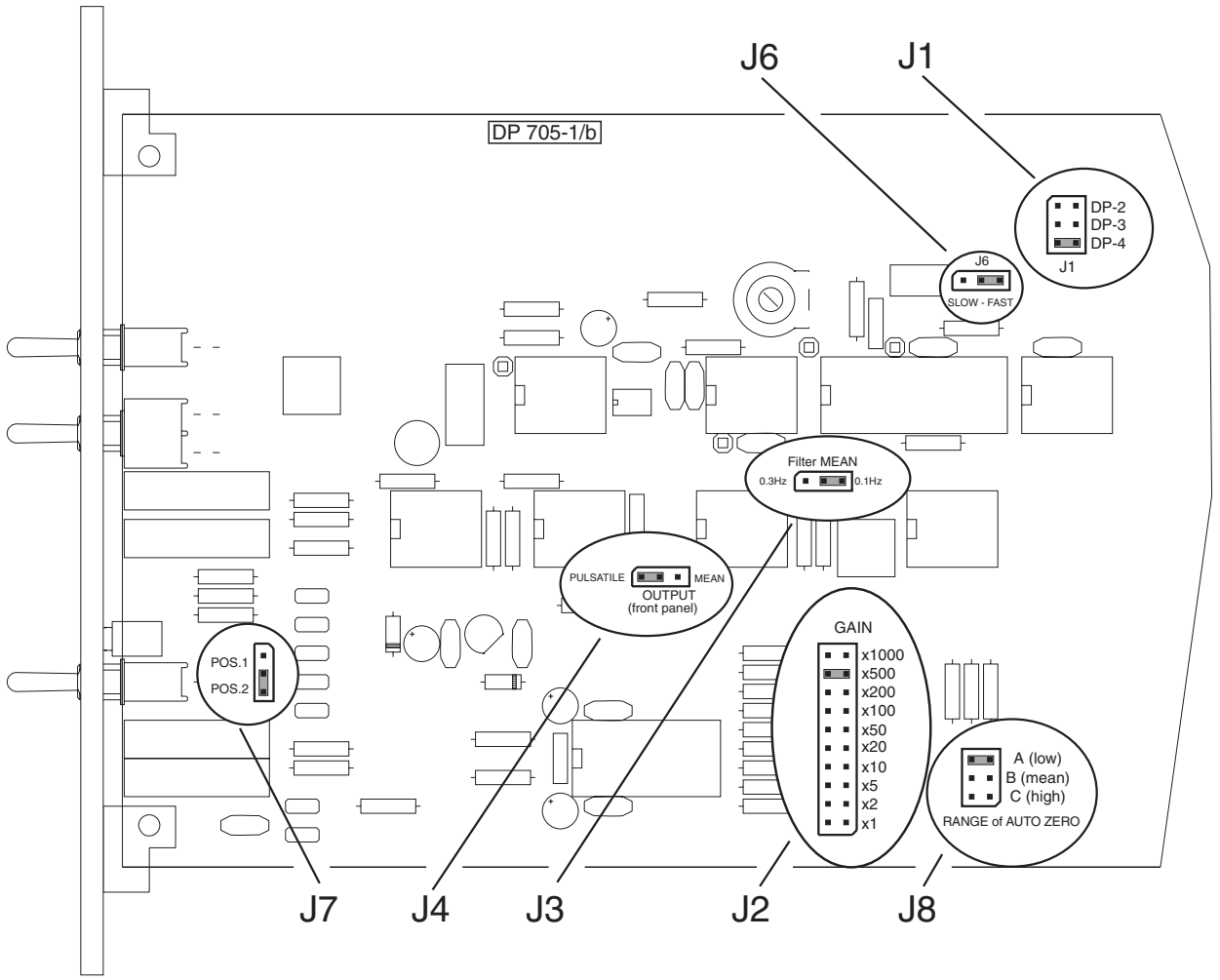
4.2.1 Protection against electrostatic discharges (ESD)

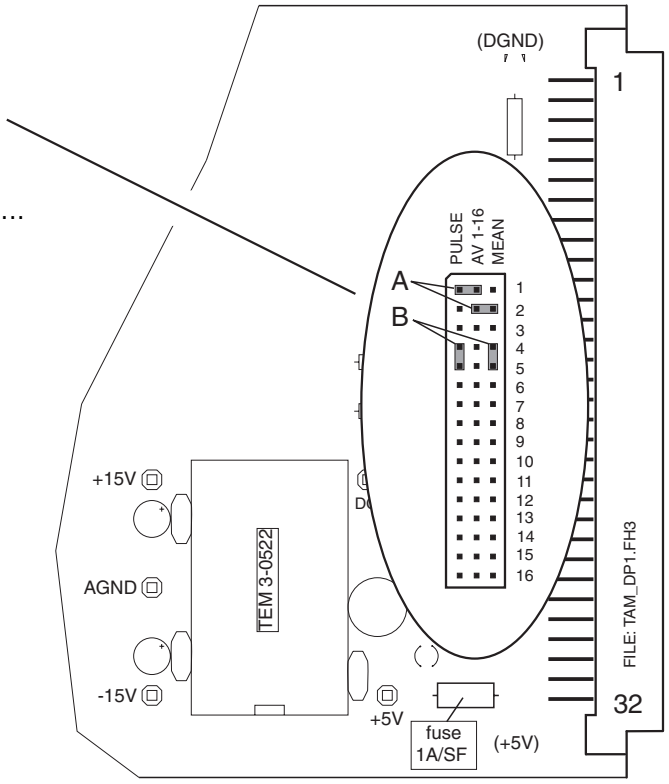
Modern electronic components are very sensitive to electrostatic discharges. Even the smallest electrostatic charge may damage the electronics or lead to faults. Therefore follow the steps described below in order to discharge any possible static electricity on your body.

- ❏ Equilibrate potentials by touching earthed metal objects, e.g. housing of some electrical equipment connected to the supply, central heating radiator etc.
- ❏ In order to avoid fresh electrostatic charges, do not move unnecessarily backwards and forwards on your working area. Where available, it is best to wear an antistatic wristband for continuous discharge of static electricity.
- ❏ When you remove the TAM from its antistatic packaging, touch first the front panel of the module to equilibrate the potentials.
- ❏ For the internal adjustments place the module flat on the foil of the antistatic packaging.
- ❏ Take care in handling the amplifier module, avoid bending the circuit board and unnecessary touching of its components.
- ❏ Before inserting the module in the housing, ensure potential equilibration between the module, yourself and the housing. First touch the metal housing before inserting the TAM.

☞ Tip When handling the module during use it is equally important to ensure that no electrostatic discharges take place through the inner pins of the input or output sockets. For this reason you should always first provide potential equilibration between yourself, the PLUGSYS and the transducer or recording system.

4.2.2 Location of the jumpers for the internal instrument adjustments





In the circle asside you see 3 coulums of pins.
On all left pins the pulsatile signal is available
The center pins are connected to the bus lines AV1 ... AV16
On all right pins you have the filtered mean signal avaialable.

To connect e.g. the pulsatile pressure signal to signal line AV1 set the jumper as described in A (upper left jumper).

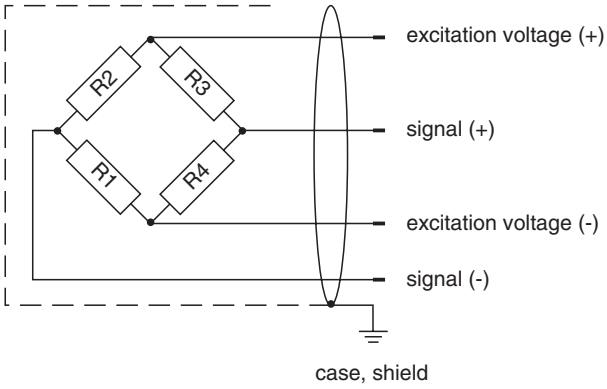
In this example the second jumper connects the MEAN signal to analog line AV2

B shows the jumpers in park position if the rear analog output is not used.

4.2.3 Input configuration of the amplifier (jumper J7)

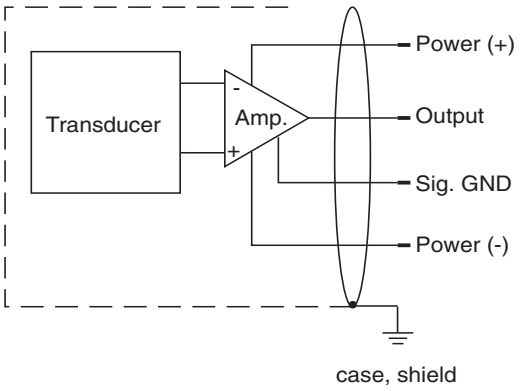
As a first step the operating mode of the input amplifier has to be selected to suit the type of transducer.

The most widely used transducers are based on a resistance bridge circuit (Wheatstone bridge) with an internal resistance in the range 100 - 1000 Ohm. The input amplifier has to be switched to push-pull input (differential amplifier), Jumper J7 on POS.2.



Typical arrangement of a transducer with bridge circuit

Less widely used are transducers with built-in preamplifier. Depending on type, the measurement signal is amplified by these active transducers up to the Volt range. The input amplifier of the TAM is switched as straight amplifier, Jumper J7 on POS.1



Typical arrangement of a transducer with preamplifier

☞ Warning In order to avoid damage to the electronics of the transducer, check first that a supply voltage of 5 Volt (50 mA) can be used as bridge supply. Special attention must be paid to correct polarity.

4.2.4 Amplification GAIN (jumper J2)

The amplification of the TAM can be adjusted over a very wide range (x2 - x10 000) to suit the requirements of the transducer. The amplification to be set depends essentially on the sensitivity of the transducer (amplitude of the measurement signal) and on the required measuring range.

☞ Note The selected gain of the preamplifier x1 / x2 / x5 / x10 / x20 / x50 / x100 / x200 / x500 / x1000 is multiplied by 10 due to the additional fixed gain of 10 of the output amplifier.

The table below provides information on typical amplifier adjustments for standard transducers and applications.

Parameter	Transducer	Sensitivity	selected Range	GAIN (x10)	Calculated Gain
blood pressure	APT300	5µV/V/mmHg	±200	x200	2000
blood pressure	APT300	5µV/V/mmHg	±400	x100	1000
blood pressure	P23XL	5µV/V/mmHg	±200	x200	2000
blood pressure	ISOTEC	5µV/V/mmHg	±200	x200	2000
blood pressure	P75	1mV/mmHg at 5V	±75mmHg	x50	133
blood pressure	P75	1mV/mmHg at 5V	±50mmHg	x50	200
Respiratory pressure	MPX	0.5mV/mbar at 5V	100mbar	x100	200
Respiratory pressure	MPX	0.5mV/mbar at 5V	50mbar	x100	400
Pneumotachometer	DLP2.5	65mV/cmH2O at 5V	2.5cmH2O	x20	60
Force	F30	40µV/V/mN	±30g = 300mN	x100	166
Force	F30	40µV/V/mN	±2g = 20mN	x500	2500
Force	F10	150µV/V/mN	±10g = 100mN	x50	133,3
Force	K30	70µV/V/g-force	±20g	x200	1428
Force	K100	30µV/V/g-force	±100g	x100	666
Force	K300	10µV/V/g-force	±200g	x100	1000
Force	K1000	3µV/V/g-force	±1000g	x100	666
Displacement	B-40	333µV/V/mm	±20mm	x50	300

Set GAIN on board with Jumper J2

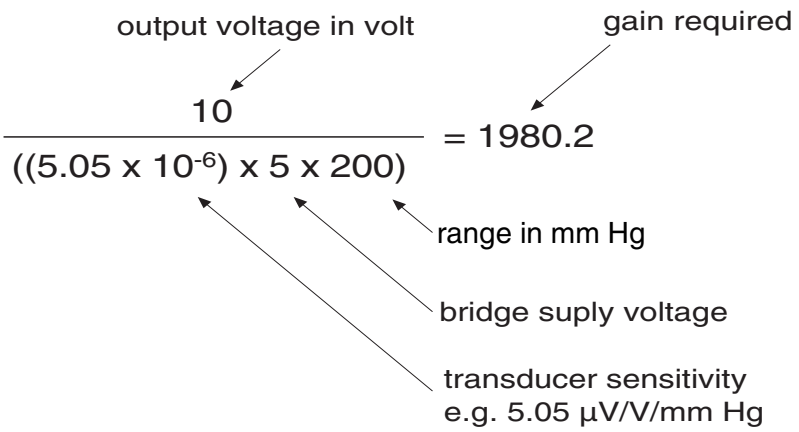
With a known transducer sensitivity (e.g. Isotec transducer 5.05 µV / Volt supply / mm Hg) the gain is calculated as follows:

Details: Range ±200 mmHg (can be selected individually)

Bridge supply voltage 5 Volt (fixed)

Output voltage range of TAM ±10 V (fixed)

Transducer sensitivity 5.05 µV / Volt supply / mm Hg (see transducer data sheet)



As the GAIN fine trimmer does only allow gain reduction, the gain jumper should allways be set to the next higher possible value. In the example above the gain should be set to 200. This gives an overall amplification of 200 (preamplifier) times 10 (output amplifier), equal to 2000x. The exact adjustment of the gain to 1980 is made through the transducer calibration on the front trimmer "GAIN 20-100%".

4.2.5 Autozero coupling (jumper J8).

Automatic zeroing (autozero) operates digitally with a resolution of 12 bit. This represents an adjustment range of 4096 steps (±2048 steps). Zero adjustment operates directly on the amplifier input so that the zero shift per step depends on the internal resistance of the transducer and on the gain setting. As a basic setting the jumper J8 has to be placed in position (B) (medium).

In case zeroing presents low accuracy (large zero shift per step), at a very large gain setting or at a high transducer resistance (internal resistance greater than 1 kOhm) the position A (low) should be selected. This reduces the effectiveness of the autozero function, there is a smaller zero shift per step.

By contrast it is possible with low gain and low transducer resistance (internal resistance 100 - 500 Ohm) that the autozero adjustment range is not sufficient. The autozero effect must then be increased, jumper in position C (high). This results in a larger zero shift per step and therefore also a larger autozero adjustment range.

4.2.6 Low pass filter setting mean output MEAN (jumper J3)

The time constant (filter action) of the MEAN signal output of the TAM can be set to 0.1 or 0.3 Hz. 0.1 Hz should be selected as the basic setting. This provides maximum smoothing of the pulsatile signal (e.g. blood pressure trace). The mean value (mean pressure) can then be obtained at the MEAN signal output. In view of the large time constant of 10 seconds in position 0.1 Hz, signal changes at the MEAN output can only be measured correctly if the measurement signal changes take place more slowly than 0.1 Hz. Otherwise part of the averaged signal is suppressed in addition to the pulsatile signal. In that case the mean value filter must be set to 0.3 Hz (3.3 seconds).

4.2.7 BNC socket Pulsatile or Mean output (jumper J4)

Jumper J4 assigns to the monitoring output on the front (BNC socket) either the pulsatile or the mean value output. In order to see the real unfiltered signal, normally the pulsatile output should be selected. On the TAM-A the measured signal then corresponds to the signal course on the bargraph.

☞ Warning — When using the mean value output at the BNC socket the output signal is no longer identical with the phasic wafeform of the measured signal. This may erroneously be considered as a fault on the output.

4.2.8 Internal signal outputs PULSE and MEAN (jumper J5)

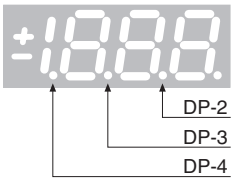
The internal signal outputs PULSE and MEAN of the TAM are each assigned by a jumper on the link connector J5 to an analogue bus line (AV1 - AV16).

☞ Warning — Be sure to select an AV bus line which is not in use and is therefore free. Duplicate connection causes short-circuiting of the two signal outputs. Details of the AV lines already being used in the system can be taken from the bus diagram of the PLUGSYS housing. See chapter 1 of the white operating instructions folder (delivered with each housing).
If there is no bus diagram it is unfortunately necessary that the settings on your system are determined again. For that purpose all the modules have to be removed in turn and the AV circuit arrangement set on them has to be checked and written down.

The diagram in Section 4.2.2 illustrates at (A) the assignment of the PULSE output to AV-1 and that of the MEAN output to AV-2. It is not essential to use both signal outputs, and the jumpers can then be stored safely on the outer pin rows as shown at (B) (parking position). In this position the jumper is ineffective.

☞ Important — The AV setting which you have made on the TAM must be documented in the bus diagram of the housing.

4.2.9 Setting of the decimal point TAM-D (jumper J1)



On TAM-D the decimal point position in the digital display can be freely selected. The indicated value then corresponds exactly of the measuring range which you require. For example, for the range ±10.00 mN the jumper should be set to position DP-3. In case no decimal point is required remove the jumper and set it to one pin. For measuring blood pressures up to 200mmHg you have to remove this jumper, so that no decimal point is displayed.

4.2.10 Mean value filter for digital display TAM-D (jumper J6)

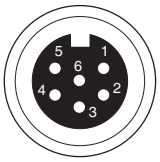
The digital display on TAM-D is preceded by the selectable signal filter. In its normal setting "FAST" (1.6 Hz) the display directly follows the input signal according to the measuring sequence. In the "SLOW" setting (0.15 Hz) there is a pronounced averaging effect. The settling time of the filter is then approx. 6 seconds.

4.3 Signal input

The signal input is a 6-pin Binder or Amphenol-Tuchel fitted socket with screw lock.

Suitable plugs: Binder Type: 09-0321-00-06
Amphenol Type: T3400501

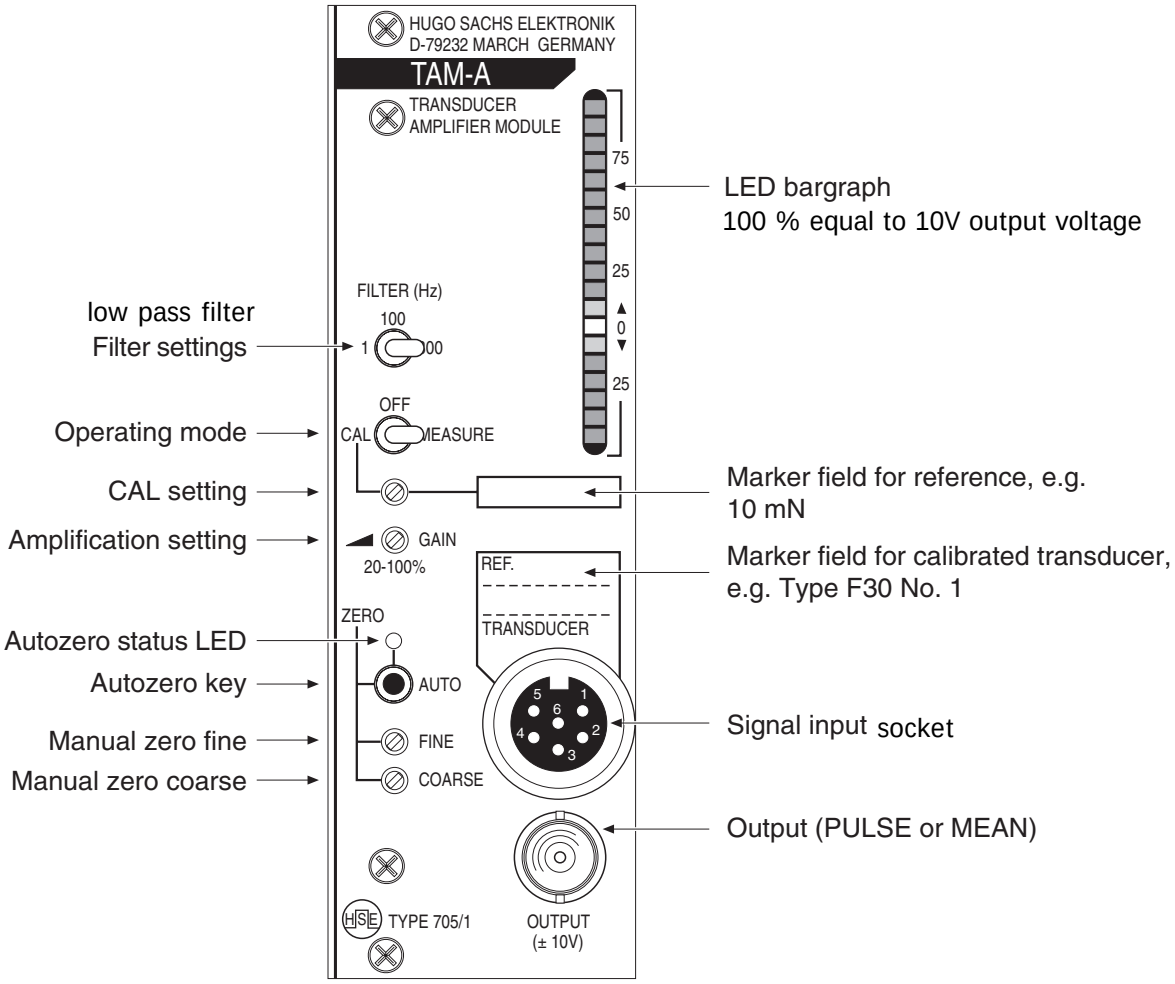
Pin connections:



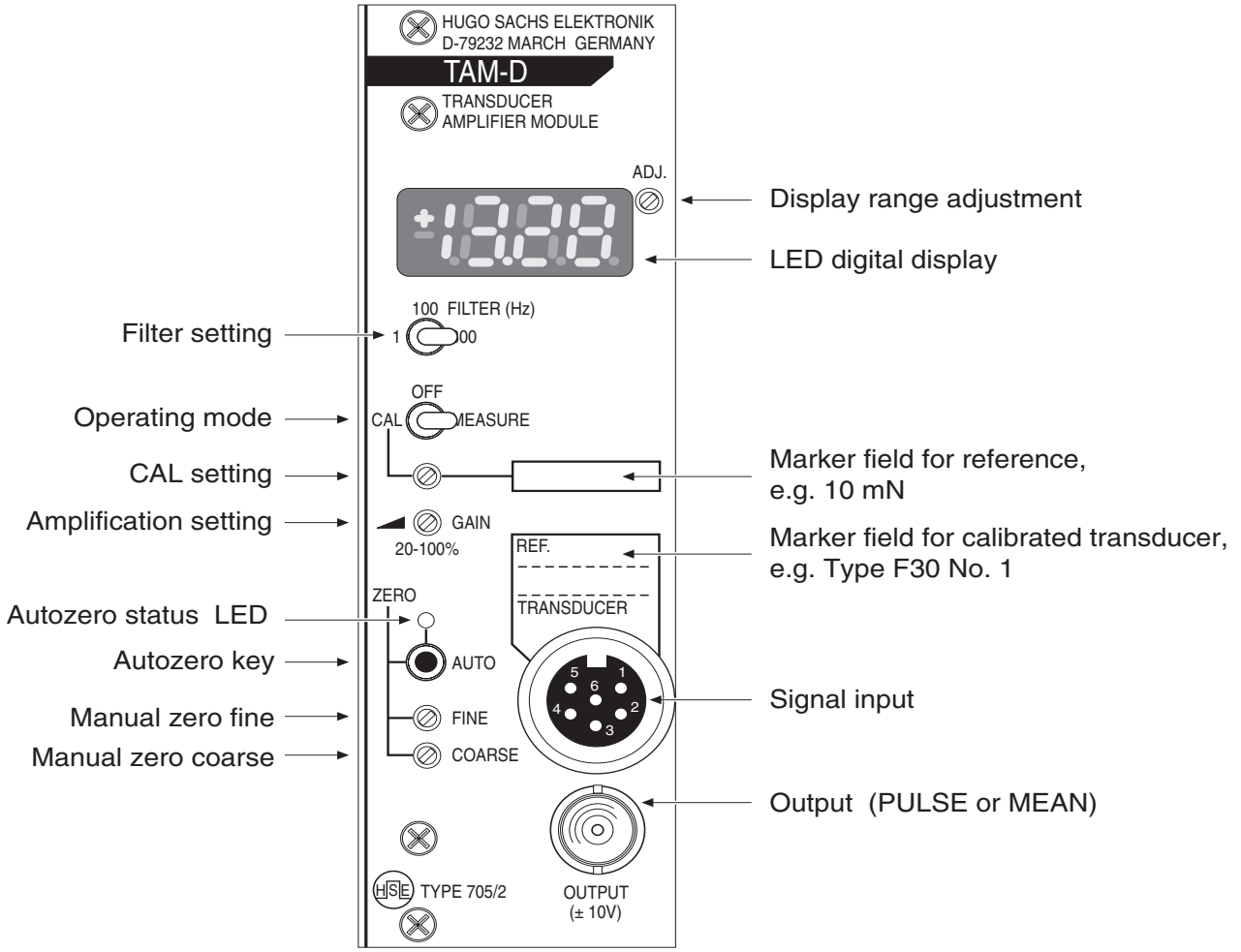
Pin 1 (+) supply +5 Volt (50 mA)
Pin 2 (-) signal input
Pin 3 midpoint of the optional internal half-bridge (+2.5 Volt)
Pin 4 (+) signal input
Pin 5 (-) supply (circuit null)
Pin 6 not used

The connector housing must be connected to the shield screen in the cable and the transducer housing (it must not be connected to the circuit null pin 5). Use only shielded cables !

5. Controls TAM-A



5.1 Controls TAM-D



6. Start-up

After you have completed the module installation, connected the transducer to the TAM, switch on the power on the housing. The first step is to calibrate the TAM to the transducer. This may involve adjusting the gain of the TAM to suit the transducer sensitivity and the required range. In addition the CAL Value (simulated static value e.g,. 100mmHg) for calibrating the recording system has to be set.

6.1 Transducer calibration

The following points have to be considered first:

- ❏ Establish the required measuring range, e.g. ±200 mmHg. Note that the maximum expected signal has to be smaller than the selected range. Do not oversee the pulsatile part of the signal (e.g. the systolic diastolic pulsation of blood pressure). Also have in mind that testing a drug may increase dramaticaly the signal amplitue. Note, that the selected range should be 10 -20 % higher than the maximum expected signal.
- ❏ Output voltage corresponding to the selected range (i.e. to ±200 mmHg).

  ☞ Important — The signal voltage span of the PLUGSYS measuring system is fixed at ±10 Volt. The goal should always be to produce maximum amplifier output to have the best ratio between useful signal and resolution. It means that under ideal conditions the range corresponds to the output voltage of ±10 Volt. On TAM-A there is a further advantage through the better deflection of the bar graph indication. The dynamic (pulsatile part) of the measured signal is much better seen.

- ❏ Determine the calibration signal, e.g. 100mmHg, for calibrating the recording system to which TAM is connected. By switching the operating mode from MEASURE to OFF and then to CAL it is possible to simulate a static value of e.g. 100 mmHg.

6.1.1 Basic settings for transducer calibration

If you bought the transducer together with the TAM amplifier module these settings already have been done in the factory. See handwritten texts on TAM frontpanel.
Furthermore it is assumed that the internal GAIN jumper already has been set according chapter 4.2.4

- ❏ Set output filter to 300 Hz
- ❏ Set operating mode to MEASURE
- ❏ Set GAIN 20-100% to 100%, fully clockwise (clicking noises) on the multi-turn trimmer
- ❏ Set fine manual zero adjustment to mid-position (19 turns anticlockwise and then 9 turns clockwise)
- ❏ Initialize the autozero function to the mid of the calibration range. To do so start the autozero function with the transducer disconnected. Since no transducer is connected to the TAM, zeroing is not possible and the function is aborted with an error message. In that case the autozero function is normalised to its mid setting. This procedure is essential to ensure that during later operation the autozero function has maximum action in both positive and negative direction. After this adjustment, connect the transducer back to the TAM.

  ☞ Important — It is essential that the housing of the input plug is screwed to the socket on the front panel. This is necessary to ensure a secure connection between cable screen and transducer housing screen. Protection against electrostatic discharges is ensured only when the plug case has been properly screwed to the socket.

  See also the description of the autozero function below (Section 7.2).

- ❏ On the TAM-D the adjustment ADJ. next to the digital display, a multi-turn trimmer, must be turned fully clockwise (clicking noises). The indicated value, referred to the output voltage, corresponds to 10 Volt = 1000 or 100% of the maximum possible range. The position of the decimal point is disregarded.

- ❏ Since the zero of most transducers is affected by its position, the transducer should during calibration be secured on the bench in its operating position, e.g. by a stand, clamp or some suitable component.

6.1.2 Transducer calibration TAM-A

Easiest calibration can be made with connecting a digital voltmeter to the BNC output on the frontpanel.
Brief description in short form (example with a pressure transducer):
Wished range 200mmHg: which means 200mmHg should be equal to 10V at the BNC output.
Adjust Zero with transducer open to air, connect pressure calibrator and attach 100mmHg,
set GAIN so that you get 5V on the analog output.

Detailed description:

- ❏ The bargraph has one fix LED on position Zero, which is always on. A second LED may be on, anywhere on the bargraph when there is no load on the transducer. Carry out an approximate zero adjustment manually with the adjustments ZERO-COARSE first and then ZERO-FINE so both LED's overlap. If a voltmeter is connected at the BNC output it should show as good as possible 0 Volt
- ❏ Start the AUTOZERO function by pressing the AUTO button in MEASURE MODE until the LED ZERO goes on, for precise zeroing. The LED ZERO must automatically go off after a few seconds and not be flashing at the end of the adjustment (no error, zero adjustment OK!).
- ❏ Using a pressure calibrator, apply the calibration reference e.g. 100mmHg to the transducer without altering the position of the transducer (zero error).
- ❏ Now take the litle red screwdriver which was delivered with the system and adjust on the GAIN 20-100% trimmer the gain so that you get e.g. 5V (50% bargraph deflection) which is equal to 5V on the output. The adjustment should be made in conjunction with the recording device (recorder, data acquisition system, oscilloscope) or a commercial voltmeter.

  In the case of the example, the output voltage of ±10 Volt is equivalent to a measurement range of ±200mmHg.

  ☞ Tip — The larger the applied calibration reference, the more accurate the adjustment can be made. The ideal situation is when the applied reference equals the measuring range.

  ☹ Sorry — In case the amplifier deflection is smaller than expected, the internal gain has to be suitably increased. The procedure for transducer calibration as described so far must then be repeated.

  ☞ Important — The final step should be to check the zero again. The calibration reference load on the transducer is removed. The signal output of the TAM must then again be exactly zero. If this is not the case, it is probable that application of the calibration reference load has shifted the transducer zero. A possible cause is a change in the position of the transducer, pulling on the connecting cable etc. In order to achieve maximum accuracy it is necessary to repeat the above adjustment procedure.

- ❏ The last step is to set the CAL value which can simulate a preset value on the TAM output. Set switch CAL-OFF-MEASURE to CAL position. A freely set static calibration value e.g. 100mmHg can at any time be simulated on the signal output of the TAM.

  Method 1: Adjustment using the recording device

  With the TAM in MEASURE mode apply to the transducer, using the calibrator, the reference value you want to simulate. Check for the reading of your recording device. On the TAM, switch now to operating mode CAL. Turn on the CAL adjustment trimmer so that your recording device shows the same reading as with the calibration reference before.

Method 2: Adjustment using a voltmeter on the BNC output

This method is possible only when the transducer calibration has been made as an exact voltage of e.g. 5V/100mmHg. Bring the TAM module in operating mode CAL and connect a voltmeter to the BNC signal output. Using the CAL adjustment the output voltage is now adjusted to 5 Volt. The output voltage in the CAL position then corresponds to the required CAL value of e.g. 100 mmHg.

❏ In order to remind the simulated calibration value e.g. 100mmHg please write the value with a soft pencil on the appropriate marker fields on the front panel of the TAM. Any existing writing can readily be removed using a soft rubber.

6.1.3 Transducer calibration on a TAM-D with a digital voltmeter or a DAQ system

The transducer calibration on the TAM-D follows essentially the same procedure as that of TAM-A. Here additionally the value you measure is displayed as a number in units (e.g. 100mmHg).

Easiest way here is to use a digital voltmeter on the BNC output socket or your data acquisition system (DAQ) for calibration. (Your DAQ system should show the applied voltage)
Brief description in short form (example with a pressure transducer):
Wished range 200mmHg: which means 200mmHg should be equal to 10V at the BNC output.
Adjust Zero with transducer open to air, connect pressure calibrator and attach 100mmHg,
set GAIN so that you get 5V on the analog output. Adjust display so that it displays 100 (100mmHg).

Detailed description:

❏ With no load on the transducer, carry out an approximate zero adjustment manually with the trimmers ZERO-COARSE first and then ZERO-FINE. Adjust Zero so that your voltmeter shows almost zero.

❏ Start the AUTOZERO function by pressing the AUTO button in MEASURE MODE until the LED ZERO goes on, for precise zeroing. The LED ZERO must automatically go off after a few seconds and not be flashing at the end of the adjustment (no error, zero adjustment OK!).

❏ Using a pressure calibrator, apply the calibration reference e.g. 100mmHg to the transducer without altering the position of the transducer (zero error).

❏ Now take the litle red screwdriver which was delivered with the system and adjust on the GAIN 20-100% trimmer the gain so that you get e.g. 5V on your Voltmeter or DAQ system. Don´t look to the digital display on the TAM-D, it is not set at this point. The adjustment should be made in conjunction with the recording device (recorder, data acquisition system, oscilloscope)

In the case of the example, an output voltage of ±10 Volt has to be set for a range of ±200mmHg.


Tip

The larger the applied calibration reference, the more accurate the adjustment which can be made. The ideal situation is when the applied reference equals the measuring range.


Sorry

In case the amplifier deflection is smaller than expected, the internal gain has to be suitably increased (jumper J2). The procedure for transducer calibration as described so far must then be repeated.


Important

The final step should be to check the zero again. The calibration reference load on the transducer is removed. The signal output of the TAM must then again be exactly zero. If this is not the case, it is probable that application of the calibration reference load has shifted the transducer zero. A possible cause is a change in the position of the transducer, pulling on the connecting cable etc. In order to achieve maximum accuracy it is necessary to repeat the above adjustment procedure.

- ❏ The next step now is to set the digital display on the TAM-D so that it displays the value in units of use. Here e.g. 100 (mmHg). Apply the calibration reference e.g. 100mmHg again to the transducer and adjust the digital display with the ADJ trimmer so that you get 100 on the display. Now your output should show 100mmHg on the display and deliver 5 Volt on the output BNC socket. If you have set the display to show one decimal you will not be able to adjust the display to more than 50.5. Please remove the module and remove the decimal point jumper (J1). Now you are able to display 100.

- ❏ The last step is to set the CAL value which can simulate a preset value on the TAM output. Set switch CAL-OFF-MEASURE to CAL position. A freely set static calibration value e.g. 100mmHg can at any time be simulated on the signal output of the TAM. Set switch CAL-OFF-MEASURE to CAL position. Turn on the CAL trimmer so that your display shows the choosen simulation value e.g. 100 (mmHg). If you switch now to CAL your TAM-D always simulates 100mmHg on the display and on the output.

6.1.4 Transducer calibration on a TAM-D with using the digital display (procedure for users who don´t have a digital voltmetern nor a DAQ system

- ❏ For evaluating the measurement signal with the built-in digital display it is important that the trimmer ADJ. on the right next to the display is turned fully clockwise. The multi-turn potentiometer has 19 turns and no fixed limit stop.
The digital display is normalised with ADJ. turned fully clockwise. The range of ±10 Volt corresponds to a reading of ±1000. The decimal point is disregarded. You can now consider the displayed value as ±10.00 Volt or as ±100.0% of the measuring range.

- ❏ The transducer calibration is therefore very simple on the TAM-D. Similar to the example in the calibration description for the TAM-A, a range of 200mmHg and a reference loading on the transducer of 100 mmHg is assumed. This corresponds to a calibration of 100mmHg per 5 Volt.

Detailed description:

- ❏ With no load on the transducer, carry out an approximate zero adjustment manually with the trimmers ZERO-COARSE first and then ZERO-FINE. Adjust Zero so that your digital display shows almost zero.

- ❏ Start the AUTOZERO function by pressing the AUTO button in MEASURE MODE until the LED ZERO goes on, for precise zeroing. The LED ZERO must automatically go off after a few seconds and not be flashing at the end of the adjustment (no error, zero adjustment OK!).

- ❏ Using a pressure calibrator, apply the calibration reference e.g. 100mmHg to the transducer without altering the position of the transducer (zero error).

- ❏ Take the litle red screwdriver which was delivered with the system and adjust on the GAIN 20-100% trimmer the gain so that you see e.g. 500 on your TAM-D Display. The output now must deliver 5V.

- ❏ The next step now is to set the TAM-D digital display so that it displays the value in units of use.
Here e.g. 100 (mmHg). Apply the calibration reference e.g. 100mmHg again to the transducer and adjust the digital display with the ADJ trimmer so that you get 100 on the display. Now your output should show 100mmHg on the display and deliver 5V on the output BNC socket

- ❏ The last step is to set the CAL value which can simulate a preset value on the TAM output. Set switch CAL-OFF-MEASURE to CAL position. A freely set static calibration value e.g. 100mmHg can at any time be simulated on the signal output of the TAM. Turn on the CAL trimmer so that your display shows e.g. 100 (mmHg). If you switch now to CAL your TAM-D always simulates 100mmHg on the display and on the output.

7. Zero compensation ZERO

Zero compensation is required to correct the transducer zero without any load on. The output signal of e.g. a Wheatstone bridge without any loading is never exactly zero. Possible causes are manufacturing tolerances in the branch resistances, the effect of position, or slight bridge unbalance through overload or compensation of an applied preload. Zero compensation consists of feeding a compensating current into the transducer bridge circuit. In this way zero compensation is independent of the amplification selected on the TAM. TAM offers manual coarse and fine adjustment as well as a very precise autozero function in order to compensate even extreme symmetry errors in a transducer bridge.

7.1 Manual zero adjustment

The effect of the COARSE zero adjustment is larger than that of the FINE adjustment by a factor of 5. In order to use the adjustment range of the FINE adjustment in both positive and negative directions it is necessary first to move the FINE adjustment roughly to its centre position. Turn the multi-turn adjustment fully anticlockwise (19 turns) and then about 8 turns clockwise. The same applies to the autozero function, see description below (Section 7.2).

Coarse adjustment with the ZERO COARSE adjustment
Fine adjustment with the ZERO FINE adjustment
Precise zero with the autozero function

Note: On TAM-D it is in principle also possible to make the precise zero adjustment using the built-in digital display and the FINE manual adjustment. It is therefore not essential to produce precise zero adjustment using the autozero function. On TAM-A however, accurate zeroing is not possible in this way because of the limited resolution of the bargraph. Precise zero adjustment on TAM-A requires the use of the autozero function.

7.2 Automatic zero adjustment.

Automatic zero compensation (autozero function) operates digitally with a resolution of 12 bit. This provides an adjustment range of 4096 steps (±2048 steps). Zero adjustment operates directly on the amplifier input and the zero shift per step therefore depends on the internal resistance of the transducer and on the gain setting (see Section 4.2.5, Zero coupling). The autozero setting is stored permanently and remains held until the next automatic zero adjustment even if the amplifier case is switched off.

- ❏ Automatic zero adjustment is possible only in operating mode MEASURE. Starting autozero in the mode OFF or CAL results in an error, the status LED above the AUTO key flashes briefly 4 times.

- ❏ Autozero can only be initiated after a waiting time of 2 seconds. This means that the AUTO push button must be held down for at least 2 seconds. This prevents unintentional initiation of a zero adjustment. Throughout the adjustment the status LED shows a steady light. After successful zero adjustment the status LED goes off immediately. In case the autozero adjustment range is not sufficient, the status LED flashes 15 times at the end of the adjustment. In addition the automatic system is normalised to the centre of the adjustment range. In order to proceed with zeroing the zero position has to be corrected manually. Automatic adjustment should then be possible (see also autozero coupling Section 4.2.5).

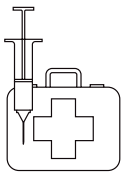
- ❏ In order to move autozero to its mid position the transducer has to be disconnected from the TAM and autozero is started. Since zeroing is now impossible the autozero function makes an unsuccessful attempt at zeroing and then normalises itself to its mid position.

8. Filter 30 - 100 - 300 Hz

A low-pass filter is arranged before the pulsatile signal output to smooth the signal wafeform. The filter action can be selected on the FILTER (Hz) switch between 30, 100 and 300 Hz (older version 1, 100and 300 Hz). The stated frequency refers to the frequency limit for -3dB amplitude loss. Normally the filter setting 300 Hz should be selected. Depending on the type of measurement signal the filter can if required be switched to 100 or 30 Hz. Always check how the filter action alters the shape of the signal.

On cardiovascular pressure measurement always use the filters 100 or 300Hz. On respiratory and tisse experiments with slow smooth muscles you can use the 30Hz filter position.
The filter should never alter the signal in its amplitude !!!

9. Maintenance notes



Any splashes of salt solution should be removed immediately with a cloth in order to prevent corrosion damage to the metal parts, the connectors and the electronics.

For cleaning the front panel, connectors and cables never use scouring powder or cleaning agents which attack plastics or aluminium.

Any dust should be removed with a lint-free cloth or with a fine dust brush.

Heavier dirt can be removed with soapy water or a domestic cleaning agent, using a soft cloth. Then wipe up with clean water. Never allow any liquid to find its way inside the instrument or into switches or sockets.

Any spots on the aluminium front panel can be removed with an ordinary plastic rubber.

The interior of the module does not require any servicing or cleaning.

9.1 Conformity

CE This product and accessories conform to the requirements of the Low-Voltage Guideline 73/23/EWG as well as the EMC Directive 89/336/EWG and are accordingly marked with the CE symbol. For conformity with the standard it is essential that the details in these Instructions are strictly observed during operation.

9.2 Technical data TAM

Construction	PLUGSYS module
Input	Differential input with an input impedance of 10^{10} Ohm through a 6-pin Binder or Amphenol-Tuchel socket with screw lock. For direct operation of resistive transducers with half-bridge or full-bridge circuit.
Input plug	Binder Type 09-0321-00-06 / Amphenol Type T3400501
Bridge supply	5 Volt / 50 mA max.
Gain	In the range 10x to 10 000x, selected by internal jumper as x10, x20, x50, x100, x200, x500, x1000, x2000, x5000 and x10000. The basic gain setting can be varied with the GAIN control within the range 20-100%.
Zeroing	1. Autozero by pushbutton 2. Manual zero through multi-turn coarse and fine trimmers
Indication TAM-A	Analogue LED bargraph, 19 LEDs (+12/null/-6) for visual indication of the measurement signal
Indication TAM-D	3½-digit LED display ±10 Volt / ±100%, or variable to suit the actual measurement
Output filter	Low-pass with 3 settings 30 - 100 - 300 Hz selected by switch
Outputs	Internally to PLUGSYS system bus: pulsatile output and additional mean value output (0.1 or 0.3 Hz) BNC socket on front panel: pulsatile output or mean value output (0.1 or 0.3 Hz) as selected internally through jumper
CAL reference	In position CAL, simulate a reference value adjustable by multi-turn trimmer, additionally zero reference in position OFF
Supply	+5 Volt 350 mA from PLUGSYS system bus
Dimensions	19" PLUGSYS module, width 8E (40.5 mm), height 3U (128.7 mm), depth Eurocard (220 mm)
Connector	DIN 41612, 96 pin VG
Weight	260g
Accessory	Operating Instructions

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Reply Form .....

Please take a few minutes of your time in order to write to us on any difficulties in understanding the Operating Instructions or in the use of the apparatus. With your feedback you will help to improve our products and the system documentation and make them more user-friendly.

Please tell us

☞ where you have found mistakes,

☞ where the arrangement was not clear and what you did not understand,

☞ and where you would like to see improvements.

Many thanks for your *kind assistance*.
Yours HUGO SACHS ELEKTRONIK -
HARVARD APPARATUS GmbH.

Your name _____

Organisation _____

Street _____

Town _____

Phone/Fax _____

e-mail _____

Please send this sheet or a copy to:

HUGO SACHS ELEKTRONIK - HARVARD APPARATUS GmbH,
Gruenstr. 1, D-79232 March-Hugstetten, Germany
Fax. (int. + 49) 7665-9200-90

Application note:

Adaptation of a blood pressure transducer to a PLUGSYS TAM-A module

Before using a blood pressure transducer (e.g. APT300, P75...) together with a Transdcuer Amplifier Module TAM-A or TAM-D you have to do some adjustments and to perform a calibration.

As the different transducers deliver a different voltage signal first the GAIN on the amplifier board must be set. Therefore you have to pull out the module from the housing. To do that just open the upper and the lower screw (with a PHILIPS screwdriver) on the front panel and pull the module out.

Coarse GAIN is adjusted on the jumper row J2.

Set GAIN for the transducers as follows:

APT300	x200
P23XL	x200
P75	x50

After you have installed the jumper in position install the module back in the housing and close the screws. Switch on main power and connect the transducer to the module.

TAM-A basic settings:

- Lowpass Filter on 300 Hz
- Move the switch CAL/OFF/ MEASURE in MEASURE position

First step is the Zero adjustment:

- Remove load from the transducer, open horizontal port on APT300 or P75 transducers to air
- Adjust Zero by pressing the AUTO ZERO button on the TAM module for 3 seconds
- The red LED light above the button lights up during automatic zero adjustment. If the module can not adjust zero the red LED light starts blinking, first is to check if switch CAL/OFF/ MEASURE is really in MEASURE position.
- If the module can not adjust Zero you have to adjust Zero manually with the COARSE trimmer below to the AUTO ZERO button. Take the delivered little red screwdriver and adjust zero, so that you see only one bar on the bargraph module at zero position. If you have a voltmeter available, connect it to the OUTPUT BNC socket. Zero Pressure should lead to 0V on the output.
- After manual adjustment repeat ZERO adjustment by pressing again the AUTO ZERO button for 3 seconds. This time the module should be able to adjust Zero automatically. LED is no longer blinking.

Upper Calibration point / setting of measuring range

First you should think about the measurement range you intend to use. The range is the area where you expect your measured signals.
In case of arterial blood pressure a range up to 200mmHg is in most cases good. (In case of measuring on hypertensive species 300mmHg is recommended).
The range and the GAIN (amplification) run contrary. If you use more GAIN the range gets smaller, if you use less GAIN the range gets larger. This means if you have e.g. to change the range from 200mmHg to 300mmHg you have to reduce the GAIN to get a larger range.

Back to our example with a range up to 200mmHg.
The TAM amplifier has an output voltage of +- 10V.
0% deflection is equal to 0V, 100% deflection on the bargraph is equal to 10V.
If we now intend to measure up to 200mmHg we have to set the GAIN so that we reach 10V (100%) for 200mmHg or 5V (50%) for 100mmHg.

- set switch CAL/OFF/MEASURE in MEASURE position
- apply a pressure of 100mmHg with your pressure calibrator to your transducer
- check if everything is thight so that the pressure remains stable and constant
- now look to the bargraph and check the deflection
- adjust the GAIN trimmer on the front panel with the little red screwdriver, which was delivered with the system
- adjust GAIN so that you get 5V (50% bargraph deflection) for 100mmHg. The output delivers the voltage of 5V.
- remove pressure from your transducer, you should get 0V on the output
- again give 100mmHg to the transducer, you should receive 5V on the output
- if this is the case all is set well. If not readjust.

In order to avoid performing a full calibration of the output to your DAQ system daily, you can set the module so that it **simulates** a value of 100mmHg in position **CAL.**

- Set switch CAL/OFF/MEASURE into CAL position. This simulates a pressure on the bargraph and on the analog outputs of the module.
- Take the little red screwdriver and turn on the CAL trimmer **(not on the GAIN !)** so that you get +5V (50% bargraph deflection) which is equal to 100mmHg.

Now all settings are done and you can switch back the module to MEASURE position and start your measurements.

Application note:

Adaptation of a force transducer to a PLUGSYS TAM-A module

Before using a force transducer (e.g. F10, F30 or K30, K100, K1000) together with a Transdcuer Amplifier Module TAM-A or TAM-D you have to do some adjustments and to perform a calibration.

As the different transducers deliver a different voltage signal first the GAIN on the amplifier board must be set. Therefore you have to pull out the module from the housing. To do that just open the upper and the lower screw (with a PHILIPS screwdriver) on the front panel and pull the module out.

Coarse GAIN is adjusted on the jumper row J2.

Set GAIN for the transducers as follows:

F10 x 50 ... x200 depending on wished range (see table chapter 4.2.4)
F30 x100 ... x500 depending on wished range
K30 x200 ... x500 depending on wished range
K100 x100 ... x500 depending on wished range
K300 x100 ... x500 depending on wished range
K1000 x100 ... x500 depending on wished range

After you have installed the jumper in position install the module back in the housing and close the screws. Switch on main power and connect the transducer to the module.

TAM-A basic settings:

- Lowpass Filter on 300 Hz
- Move the switch CAL/OFF/ MEASURE in MEASURE position

First step is the Zero adjustment:

- Remove load (weight) from the transducer
- Adjust Zero by pressing the AUTO ZERO button on the TAM module for 3 seconds
- The red LED light above the button lights up during automatic zero adjustment. If the module can not adjust zero the red LED light starts blinking, first is to check if switch CAL/OFF/ MEASURE is really in MEASURE position.
- If the module can not adjust Zero you have to adjust Zero manually with the COARSE trimmer below to the AUTO ZERO button. Take the delivered little red screwdriver and adjust zero, so that you see only one bar on the bargraph module at zero position. If you have a voltmeter available, connect it to the OUTPUT BNC socket. Zero Pressure should lead to 0V on the output.
- After manual adjustment repeat ZERO adjustment by pressing again the AUTO ZERO button for 3 seconds. This time the module should be able to adjust Zero automatically. LED is no longer blinking.

Upper Calibration point / setting of measuring range

First you should think about the measurement range you intend to use. The range is the area where you expect your measured signals.
In case of force signals and the differnt transducers a range the range can be wide.
The range and the GAIN (amplification) run contrary. If you use more GAIN the range gets smaller, if you use less GAIN the range gets larger.
As an example let say the range should be up to 10g (approx 10cN = 100mN)

Back to our example with a range up to 10g.

The TAM amplifier has an output voltage of +- 10V.
0% deflection is equal to 0V, 100% deflection on the bargraph is equal to 10V.
If we now intend to measure up to 10g we have to set the GAIN so that we reach 10V (100%) for 10g or 5V (50%) for 5g.

- set switch CAL/OFF/MEASURE in MEASURE position
- attach a calibration weight of e.g. 5g to your transducer
- now look to the bargraph and check the deflection
- adjust the GAIN trimmer on the front panel with the little red screwdriver, which was delivered with the system
- adjust GAIN so that you get 5V (50% bargraph deflection) for 5g. The output delivers the voltage of 5V.
- remove the calibration weight from your force transducer, you should get 0V on the output
- now hang 1g weight to the transducer, you should receive 1V on the output
- add an other gram and you should receive 2V on the output
- if this is the case all is set well. If not readjust.

In order to avoid performing a full calibration of the output to your DAQ system daily, you can set the module so that it **simulates** a value of 1g or 5g in position **CAL.**

- Set switch CAL/OFF/MEASURE into CAL position. This simulates a force on the bargraph and on the output socket of the module.
- Take the little red screwdriver and turn on the CAL trimmer **(not on the GAIN !)** so that you get +1V (10% bargraph deflection) which is equal to 1g.

Now all settings are done and you can switch back the module to MEASURE position and start your measurements.

- If you e.g need more accuracy but less range you can increase the GAIN e.g. by a factor of 2. (1g = 2V, Range will be halfed then)
- attach a calibration weight of e.g. 1g
- now look to the bargraph and check the deflection
- adjust the GAIN trimmer on the front panel with the little red screwdriver, which was delivered with the system
- adjust GAIN so that you get 2V (20% bargraph deflection) for 1g. The output delivers the voltage of 2V.
- remove weight from your force transducer, you should get 0V on the output
- again hang 2g to the transducer, you should receive 2V on the output
- add an other gram and you should receive 3V on the output
- if this is the case all is set well. If not readjust.

Important Remember that if you use a force transducer to measure the tension of an isolated muscle preparation, all tissues require a preload. The preload is part of the measurement signal and must be included in the measurement range when you select it.
You may have a tissue which requires 1000mg of preload to develop a contractile force of 200mg. In that case you can not select a range of 500mg which would easily cover the contractile force, therefore you must select a range of 2000mg which covers preload and contractile force added on.