OPERATING INSTRUCTIONS

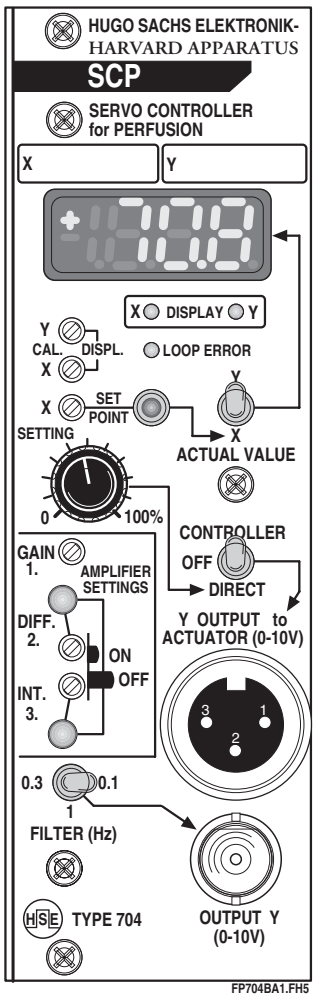
for the

PLUGSYS® Module

Servo Controller for Perfusion (SCP)

Typ 704

(Version 1.1 / June 2005 / Zi)



OPERATING INSTRUCTIONS

for the

PLUGSYS® Module

Servo Controller for Perfusion (SCP) Typ 704

(Version 1.1 / June 2005 / Zi)

Contents

1.0 Introduction, manufacturer's details

These Operating Instructions describe the function and the use of the PLUGSYS® Module Type 704. They represent an essential part of the apparatus and must be kept close to the apparatus, accessible to all users.

All the information in these Instructions have been assembled after careful examination but it does not represent any warranty of product properties. Alterations in line with technical progress are reserved.

Manufacturer:

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1.1 Copyright

1.2 Trademarks

1.3 Safety notes

The unit is designed for use in laboratories, light industrial premises and offices. Operation in hazardous areas and/or in a flammable atmosphere is not permitted.

2.0 Unpacking

It is usually the case that the unit has already been unpacked when these Operating Instructions come to hand and can be read. As you have noted, the unit does not come with any special packing; it is packed in a carton with padding material in the usual way. It is therefore particularly important to ensure that you do not inadvertently „discard" small accessory items together with the packing material.

3.0 List of items

The module is normally supplied fitted into a housing, with the following accessories:

1 Operating Instructions
1 output cable suitable for „actuator" or with plain wire tails
1 screwdriver for setting the operating parameters of the module

4.0 General description, application

The Servo Controller for Perfusion (SCP) is a specially developed, classical PID control amplifier of analogue design, arranged as a PLUGSYS® module. It is intended for organ perfusion in physiological or pharmacological research laboratories. Its purpose is to control and stabilise the perfusion pressure or the perfusion flow at a set value during perfusion.

In addition to the SCP module, a functioning control system requires a pump (roller pump, centrifugal pump ...) which has a 0 - 10 V control input and whose output produces an adequate flow for the perfusion concerned. The following additional components are required, depending on whether pressure or flow has to be controlled:

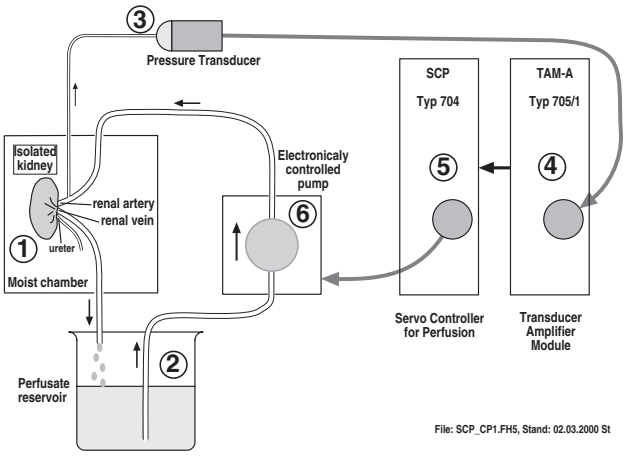
(a) for **constant pressure** perfusion: a pressure transducer, e.g. Isotec, and a bridge amplifier, e.g. HSE Transducer Amplifier Module TAM-A, Type 705/1 or TAM-D Type 705/2.

(b) for **constant flow** perfusion: a flowmeter with a suitable flow transducer, e.g. HSE Transit Time Flowmeter Module Type 700 as well as a Probe N with a suitable diameter (1N - 20N) or flow range.

4.1 Control system for constant-pressure perfusion

A diagram of a control system for constant-pressure control is shown alongside, using kidney perfusion as example. The required perfusion pressure (= set pressure = SETPOINT X) is set on the SCP. This output signal controls the flow rate of the pump.

Operation: the pressure transducer (3) measures the perfusion pressure close to the organ and passes this to the bridge amplifier TAM-A (4). The output signal of the TAM-A corresponds to the perfusion pressure present at the organ (= actual pressure = X). This pressure signal is passed through the PLUGSYS® system bus to the IN X input of the SCP (5). The SCP compares this ACTUAL signal with the SET VALUE (= SETPOINT X) and produces a control signal (Y) which operates the pump in such a way that the perfusion pressure agrees as closely as possible with the set value.

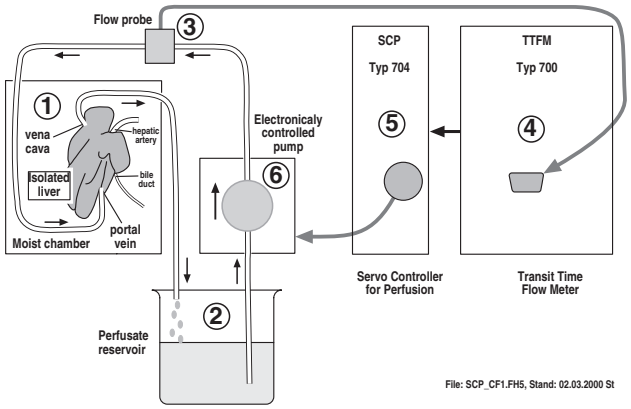


Control system for constant-pressure perfusion using kidney perfusion as example.

4.2 Control system for constant-flow perfusion

The diagram alongside shows a control system for constant-flow control, using liver perfusion as an example. The required perfusion flow (= flow setting = SETPOINT X) is set on the SCP whose output signal controls the flow rate of the pump.

Operation: the flow transducer (3) measures the perfusion flow and passes this to the flowmeter TTFM (4). The output signal of the TTFM corresponds to the actual perfusion flow at the organ (= actual flow = X). This flow signal is passed through the PLUGSYS® system bus to the IN X input of the SCP (5). The SCP compares the actual signal with the SET VALUE (= SETPOINT X) and produces a control signal for the pump (6) so that the flow rate corresponds as closely as possible to the set value.



Control system for constant-flow perfusion using liver perfusion as example

5.0 Controls, description and function

1 Output socket for connection to the actuator. In most cases this is a pump with external control. Pin connections:
Pin 1: output 0 - 10 V
Pin 2: null (reference null)
Pin 3: not used

2 Switch for selecting the output voltage Y of the SCP:
- DIRECT: adjustment by potentiometer (11)
- OFF: output switched off
- CONTROLLER: output of the control circuit. Only in this switch position the control loop is closed!

2a LED (red). This LED flashes when the control system malfunctions for any reason.

3 Switch for selecting the indicated value on the digital display (4):
X: indication of the actual controlled value, (= ACTUAL VALUE) e.g. 70 mmHg. On pressing the button (10) the set value selected on trimmer (9) is indicated.
Y: indication of the output voltage Y to the actuator.

3a Two LEDs (green) to show the value indicated on the display, X or Y.

4 Digital display, range 0 ± 1999. The decimal point can be set in any position by an internal adjustment (cf. Section 8.3).

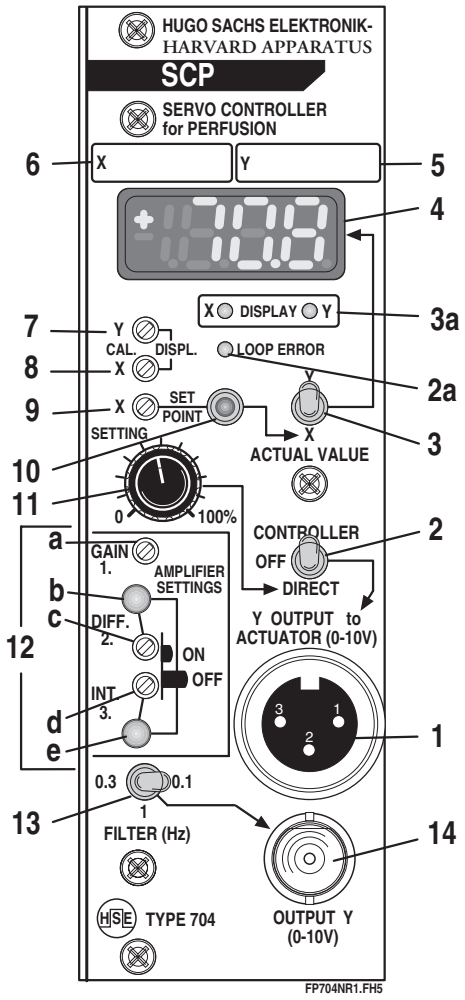
5 Writing field for marking the unit of the Y value, e.g. ml/min, % or rpm etc.

6 Writing field for marking the unit of the X value, e.g. mmHg (for constant-pressure perfusion), ml/min or l/min (for constant-flow perfusion).

7 Trimmer for calibrating the indication of the Y value.

8 Trimmer for calibrating the indication of the X value, e.g. 70 (mmHg).

9 Trimmer for setting the required SET value, e.g. 70 mmHg. The set value is indicated on the display by pressing button (10) (switch (3) set to X). It is necessary that the indication has been previously calibrated (Item 8).



10 Button for indicating the selected SET value (see Item 9).

11 Knob for directly adjusting the control voltage to the actuator. It becomes effective on the actuator when switch (2) is set to DIRECT. The selected control voltage can be indicated by moving the switch (3) to position Y.

12 Control for adjusting the characteristic of the controller. The settings depend on the static and dynamic properties of the control loop and have to be adjusted for optimum control and stability of the controlled value. NOTE: the recommended procedure: 1. 2. 3. For further details see Section 5.4).

a: trimmer GAIN for adjusting the controller amplification.

b: pushbutton switch for switching the derivative component of the controller on and off.

c: trimmer for adjusting the amplitude of the derivative component.

d: trimmer for adjusting the integral component of the control amplification.

e: pushbutton switch for switching the integral component of the controller on and off.

13 Switch for selecting the filter (low pass) on the signal Y at output (14).

14 BNC output socket for the Y signal 0 - 10 V. When using a roller pump as actuator this signal represents the flow rate provided there is a linear relationship between flow rate and operating voltage (determine flow rate by volumetric measurement and calibrate with trimmer (7) on display (4)!).

6.0 Starting up

6.1 Preparation

Before the unit can be put into operation it must be installed in a housing together with the bridge amplifier or flowmeter required for its operation. See Sections 4.1 and 4.2.

The perfusion system with the control circuit must be assembled essentially as shown in the illustrations in Section 4.1 or 4.2 resp., and appropriate electrical connections have to be made in order to close the control loop.

Calibration: as part of preparation, all units used in the control loop have to be calibrated. Select calibration values so that they are as close as possible to the values expected or set in the subsequent experiment. If, for example, a value of 70 mmHg is to be set during constant-pressure perfusion (= setpoint 70 mmHg), it is advisable to choose 70 mmHg as calibration value.

6.2 Preliminary notes

Principle: in order not to complicate the following description unnecessarily, the explanation has been limited to pressure control as an example. If the perfusion system is based on flow control, the reference to pressure has to be replace by flow, and the pressure measuring system by a flowmeter system (Sections 4.1, 4.2).

In the description below it is assumed that the perfusion system has been fully assembled and that there is a closed control loop for **constant-pressure perfusion at 70 mmHg**. In addition it is assumed that the pressure measuring system (pressure transducer + bridge amplifier) has been calibrated and the CAL value has been adjusted to 70 mmHg.

For the initial test runs it is advisable to replace the perfused organ by a piece of tubing and to simulate the flow resistance of the organ by partly squeezing the tubing. The medium used during simulation should be ordinary mains water or distilled water.

NOTE: the numbers (NN) in the text below refer to the illustration on the next page!

Before you switch on, the controls of the SCP should be set as follows:

- switch (2) to „DIRECT“
- knob „SETTING“ (11) fully anticlockwise on „0“
- switch (3) on „X“
- both pushbutton switches (12b) and (12e) to „OFF“ (released).

NOTE: when using a pump which is not self-priming, e.g. a centrifugal pump, you have to ensure before switching on that the pump head and the suction tubing are filled with liquid!

6.3 Switching on

Now switch on the equipment (PLUGSYS® housing with SCP and bridge amplifier, also pump).

- Operate the calibration key/switch on the bridge amplifier (TAM-A or D) to simulate a pressure of e.g. 70 mmHg. Use trimmer (8) „CAL.DISPL.X“ to adjust the indication on the SCP to the calibration value (e.g. 70 mmHg).
- Now adjust the required perfusion pressure (= setpoint = 70 mmHg) on trimmer (9) „SETPOINT X“. Press key (10) to indicate the set value on the digital display of the SCP.
- On the bridge amplifier (TAM-A or D) switch from Calibration to Measurement and perform a zero adjustment.
- Next turn the control (11) „SETTING“ slowly clockwise and observe as the pump starts to operate. The pressure in the perfusion system should now increase. If necessary you may have to increase the flow resistance (squeezing the tubing a little more! see above). The required perfusion pressure (70 mmHg) should be reached at the expected perfusion flow when the „SETTING“ knob is within the range 30 to 70%. If this is not the case, employ a more suitable pump or (in the case of a roller pump) use pump tubing of a more suitable diameter (with a larger or smaller diameter).

- Close the control loop!. Now move the switch (2) to the „CONTROLLER“ position so that the control loop is closed and check how the perfusion pressure changes. Depending on the setting of the control amplification (trimmer (12a) „GAIN“, the perfusion pressure will be more or less below the required pressure setting (SETPOINT X). If the control amplification is too large this may result in undamped control oscillations. In this case you should set switch (2) back to the „DIRECT“ position, reduce the control amplification „GAIN“ with trimmer (12a) (turn anticlockwise) and then try to close the control loop again.

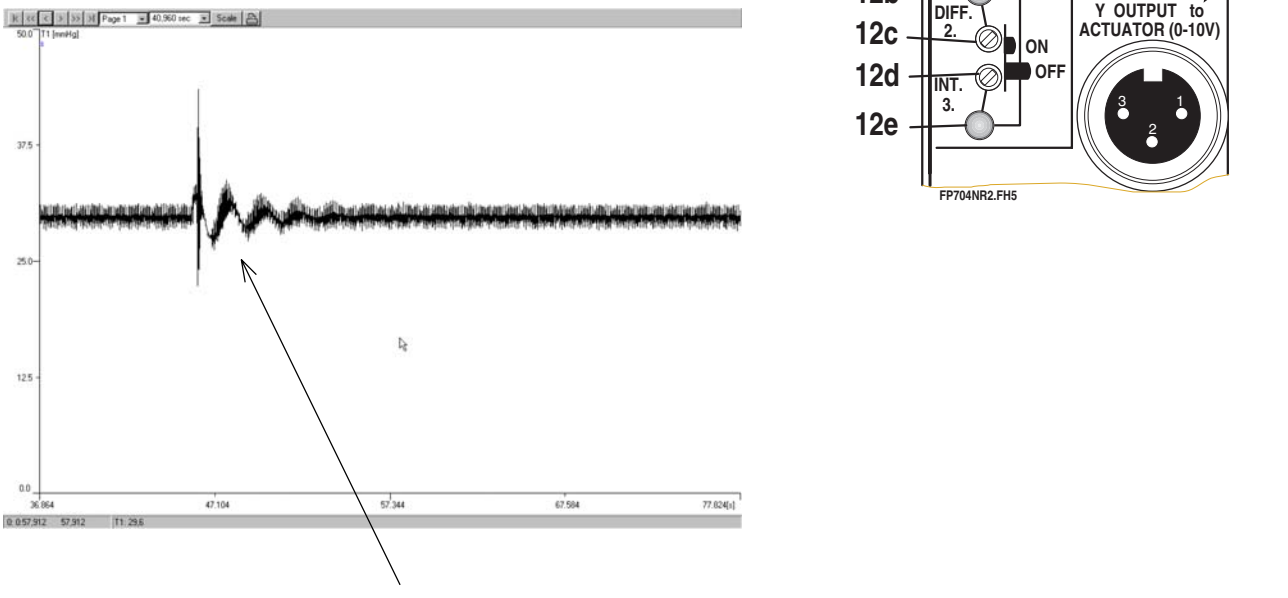
The next step consists of optimising the dynamic action of the controller so that pressure variations caused by alterations in the perfusion circuit are evened out as quickly as possible without any overshoot (see 5.4).

6.4 Adjusting the control action

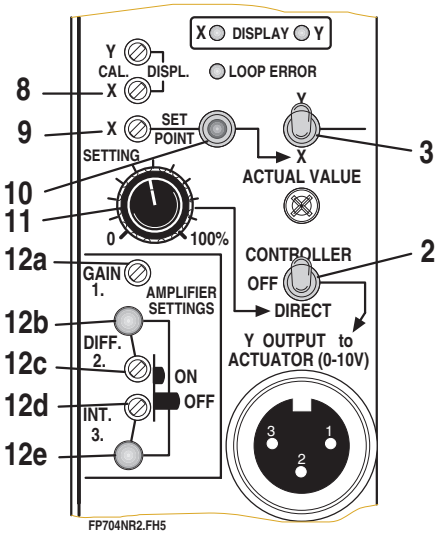
The requirement for the controller to respond as quickly and accurately as possible to variations in the flow resistance of the perfused organ involves individual adjustment of the controller characteristics to the particular perfusion system. With optimum controller adjustment the pump is so controlled that the actual value (here the perfusion pressure) is adjusted to the pressure setting (setpoint) within minimum time and without any overshoot of the actual pressure (aperiodic limiting condition).

We recommend that you adjust the control action by following the markings on the front panel: 1. - 2. - 3. Ensure that the two pushbutton switches (12b) and (12e) are OFF (the red buttons must project slightly above the front panel surface!), before you start the adjustment. Switch on the „DIFF“ (= derivative component) with the pushbutton switch (12b) only after „GAIN“ has been adjusted satisfactorily.“INT“ (= integral component) should also only be adjusted [with pushbutton switch (12e)] after „DIFF“ has been adjusted.

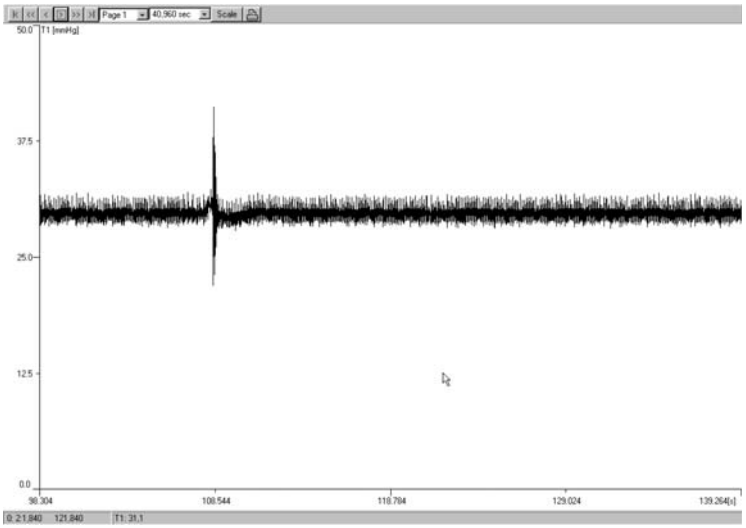
1. Adjusting GAIN! Using trimmer (12a) „GAIN“ adjust the control amplification so that damped oscillations of 1 to 3 deflections are produced when you disturb the controlled element, e.g. by brief additional slight squeezing of the tubing (see above). The resulting permanent deviation of the actual value by about 10% from the setpoint is unimportant and without significance in the first adjustment step.

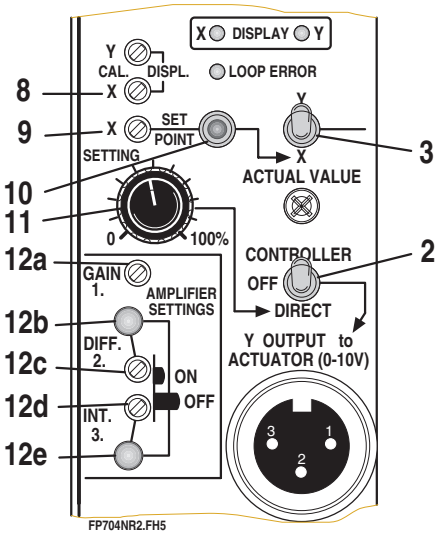


Damped oscillations, after 4 oscillations the signal is stable

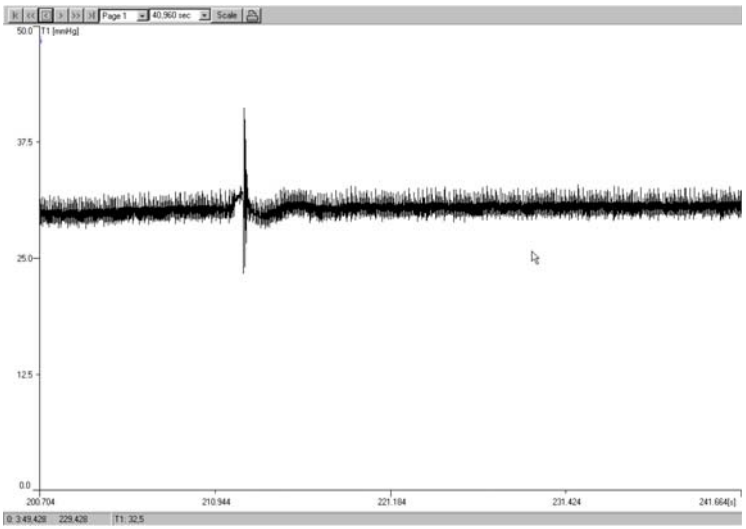


2. Adjusting DIFF! Next use pushbutton switch (12b) to switch in the derivative component of the control amplifier and adjust the so-called „derivative time“ on trimmer (12c) DIFF so that the deviations observed under 1. take place more rapidly. The actual deviation from the setpoint observed under 1. remains unchanged, only the dynamic action should be improved.

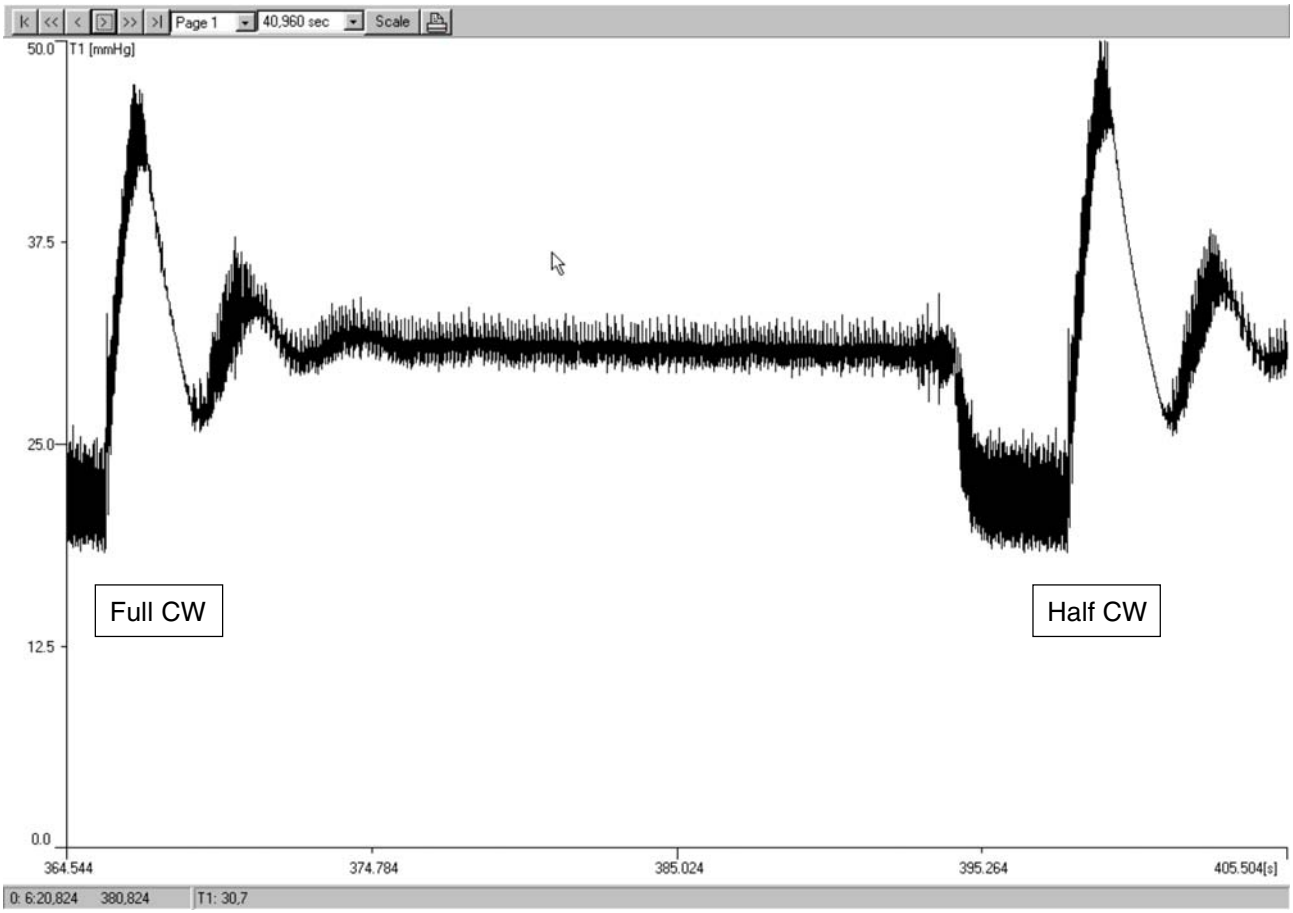




3. Adjusting INT! Now use pushbutton switch (12e) to switch in the integral action of the control amplifier and adjust the trimmer (12d) INT. so that the oscillations observed under 1. and 2. are further improved. In addition you should now note that the control deviation has disappeared. The measured pressure (= actual value) now agrees with the required pressure (= setpoint).

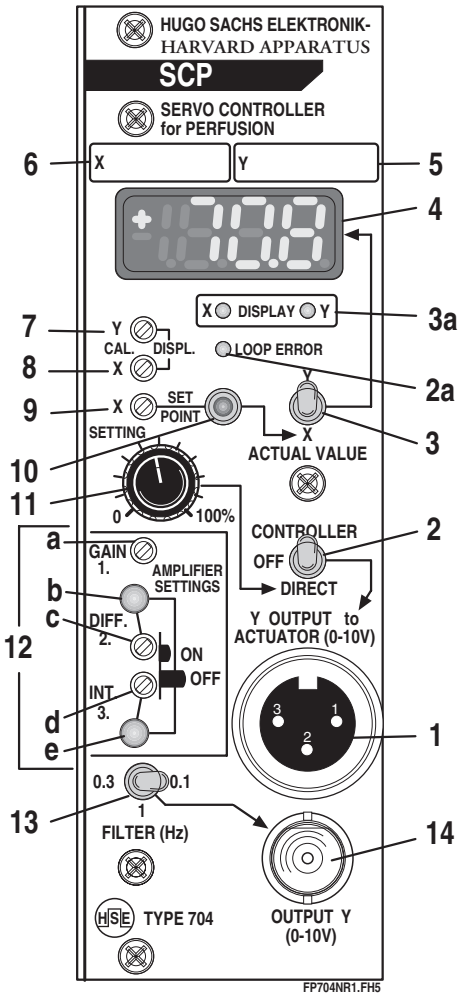


The INT control has no major effect on small perfusion systems, it is mainly set to the maximum (fully CW). It has an effect on large changes of the X-value which is not the case in organ perfusion applications. See below the effect on a large change of perfusion pressure with the control set fully CW and half CW. With the maximum setting the overshoot is better damped. In large perfusion systems it might be necessary to reduce the INT. effect slightly to avoid damping of the loop control.



6.5 Adjusting the display for the "Y" Value

After the loop control has been adjusted the last step is to set the display for the "Y" value. The "Y" value is the voltage applied to the pump to maintain the setpoint. Depending on the mode constant pressure or constant flow it is proportional to the perfusion flow or perfusion pressure. It is therefore possible to display the "Y" value in the relevant units that means ml/min, l/min... or mmHg.



Constant pressure mode (see 4.1)

The voltage for the "Y" value is proportionall to the perfusion flow. To set the display for the flow value proceed as follow:

- set knob 11 "SETTING" on 0% (fully CCW)
- set switch 2 in position "DIRECT"
- set switch 3 in position "Y"
- set knob 11 "SETTING" on about 50%
- measure flow at the pump (using a flowmeter or a start-stop watch and a graduated cylinder)
- adjust trimmer 7 to have the display showing the measured flow.

Constant flow mode (see 4.2)

The voltage for the "Y" value is proportionall to the perfusion pressure. To set the display for the pressure value proceed as follow:

- set controller 11 "SETTING" on 0% (fully CCW)
- set switch 2 in position "DIRECT"
- set switch 3 in position "Y"
- replace the perfused organ by a piece of tubing at the outflow of the pump and simulate the flow resistance of the organ by partly squeezing the tubing
- connect a pressure measurement device(pressure transducer + amplifier) between pump and flow resistance
- set controller 11 "SETTING" on about 50%
- adjust the flow resistance to measure a pressure near the expected operating pressure
- read the pressure at the pressure measurement system
- adjust trimmer 7 to have the display showing the measured pressure.

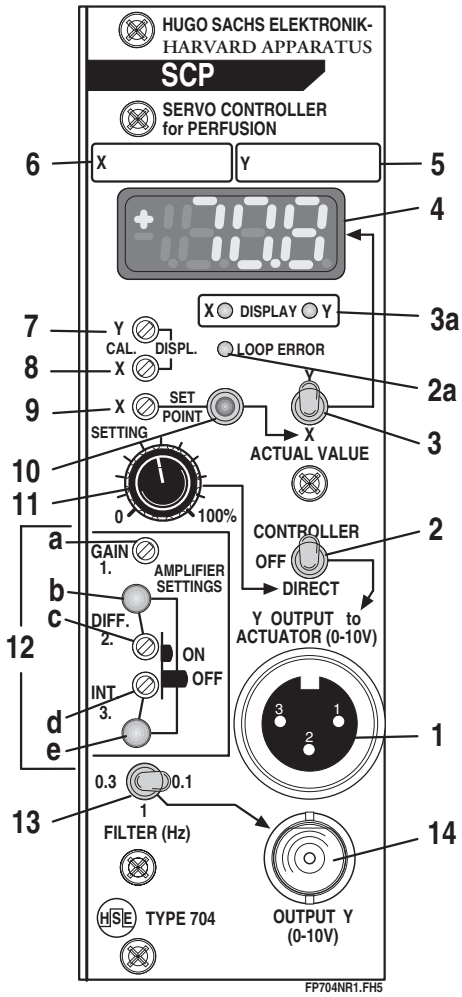
The flow or the pressure can also be recorded on the output 14. The connected recording device can be calibrated easily. Proceed as follow:

- connect the recording device or data acquisition system on 14 (output voltage in the range of 0-10 Volt)
- set controller 11 "SETTING" on 0% (fully CCW)
- set switch 2 in position "DIRECT"
- set switch 3 in position "Y"
- set Filter (13) to 1 Hz
- flow is now 0 ml/min, l/min... (pressure is 0 mmHg), this is the first calibration point.
- set controller 11 "SETTING" on any value between 0 and 100%
- flow or pressure is now the value shown by the digital display, this is the second calibration point.
- set the "Filter" to the adapted value for the experiment.

The equipment is now ready for an experiment

7.0 Starting an experiment

- set switch 2 on "OFF"
- set controller setting on 0%
- set switch 3 on "X"
- set switch 2 on "DIRECT"
- turn control 11 slightliy CW to assure a low basic flow for cannulating the organ by avoiding air emboly during cannulation
- after cannulating, set switch 2 to "OFF" after 1 or 2 seconds set the same switch to "CONTROLLER", the pump should run until the setpoint is reached and at that timepoint the pump speed is controlled by the SCP module.



Important:

If at any timepoint the pump is running at maximum speed, there must be somewhere a leak. Set immediately the switch 2 in position "DIRECT", set the controller 11 for a reasonable value and search for the leak. After clearing, again set switch 2 first on "OFF" and after 1 or 2 seconds on "CONTROLLER"

The setpoint can be modified at any time by pressing the button 10 and setting the new value using the trimmer 8.

Never switch off the pushbuttons 12b and 12e during the experiment.

8.0 Faults and remedies

Fault	Cause (possible)	Remedy
Pump does not rotate although all the units are switched on and everything else functions normally.	(a) Connecting cable from OUTPUT Y of SCP to remote control input of pump is not plugged in or is not correctly wired up. (b) Switch (2) of SCP is set to OFF. (c) Switch (2) of SCP is set to DIRECT and the knob (11) is turned fully anticlockwise to „0“. (d) Pump is not set for correct remote control function.	(a) Check connecting cable. (b) Move switch (2) either to DIRECT [see (c)] or to CONTROLLER. (c) Turn knob (11) slowly clockwise and observe pump; read Section 6.3. (d) Make correct settings on pump according to its Operating Instructions (usually internally).
Pump runs at maximum speed, the selected setting (pressure or flow) is greatly exceeded.	The control loop is not closed! If the internal electrical connections are correct there may be several faults: (a) Switch (2) on the SCP is not set to CONTROLLER. (b1) Pressure measurement (in constant-pressure perfusion) is not functioning correctly. (b2) Flow measurement (in constant-flow perfusion) is not functioning correctly.	(a) Move switch (2) on the SCP to CONTROLLER. (b1) Check pressure measuring system (Is pressure transducer connected? Are stopcocks set correctly? Tubing connections? Settings on bridge amplifier? ...) (b2) Check flow measuring system (Is flow transducer connected? Free from bubbles? Settings on flowmeter? ...)
The control system is operating correctly but the actual value (measured pressure or flow) is below the set value (SETPOINT X).	The integral component of the controller is not switched on.	Switch on pushbutton switch (12e) „INT.“ (the red pushbutton is slightly below the hole in the front panel after switching on!).
The control system performs undamped oscillations; the actual measured value (perfusion pressure or flow) does not settle down to a steady stable value but performs sinusoidal variations of a smaller or larger amplitude.	The control characteristics have not been correctly adjusted to suit this particular perfusion system.	Re-adjust the control action according to Section 6.4.
On changes in the flow resistance the system responds with a damped oscillation of a few periods, then reaches a quasi-static value which however does not remain steady.	The control characteristics have not been correctly adjusted to suit this particular perfusion system. In most cases the controller amplification GAIN has been set too large.	Re-adjust the control action according to Section 6.4.

9.0 Installing the module in the housing

The SCP module is arranged as PLUGSYS® module and has a width of 8 E corresponding to 2 slots. Before the unit can be put into operation it has to be installed in a housing, together with the bridge amplifier or flowmeter which is also required (see above). It can be installed directly in any housing with a system bus. An exception is the PLUGSYS® MiniCase Type 609 in which the SCP can also be operated; however the installation requires some solder connections so that it is only supplied fully installed from the factory.

9.1 Installation procedure

Normally when a complete control and perfusion system has been ordered, the system is supplied fully installed and assembled. The details in this Section can then be disregarded.

A number of internal adjustments have to be made before the module can be installed in its housing. The adjustments described in detail in Section 9.3 must first be carried out. It is essential to observe the precautions described in Section 9.2 in order to prevent electrostatic discharges.

Basic procedure (see also detailed description in the Operating Instructions for the housing).

- Switch off the housing and pull out the mains supply plug.
- Remove the blank panel at the housing slot position intended for the SCP.
- Make the internal adjustments according to Section 9.3.
- Insert the SCP 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 supply cable to the housing, and plug in the output cable to the actuator (pump).

9.2 Protection against electrostatic discharges (ESD).

Modern electronic components are very sensitive to electrostatic discharges. Even the smallest electrostatic charges may damage the electronics or lead to faults. Therefore follow the steps 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 in your working area. Where available, it is best to wear an antistatic wristband for continuous discharge of static electricity.

When you remove the SCP 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 module, avoid bending the circuit board and unnecessarily touching of its components.

Before inserting the module in the housing, ensure potential equilibration between the module, yourself, and the housing. Touch the metal housing first before inserting the SCP.


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 provide potential equilibration between yourself, the PLUGSYS® and the transducer or recorder.

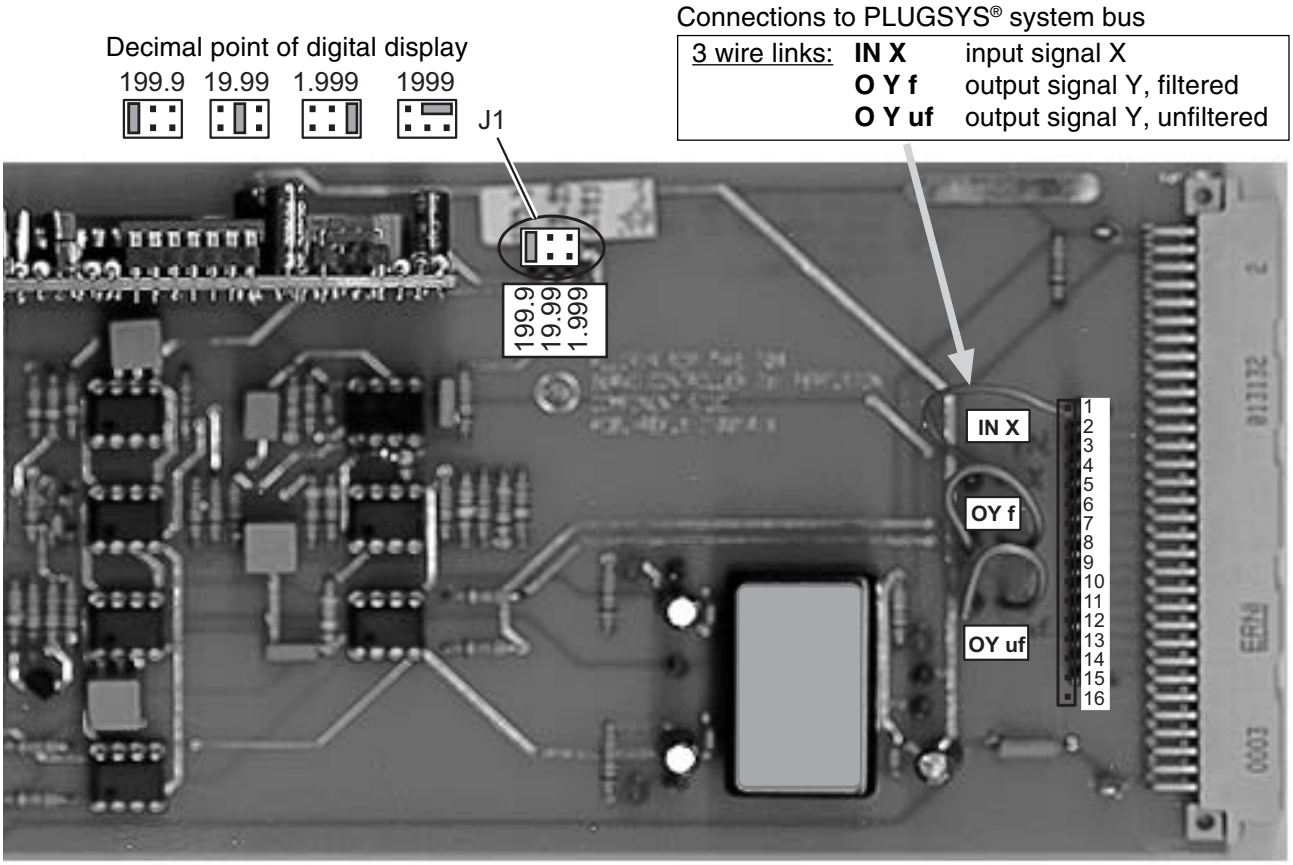
9.3 Internal settings, links

In order to adapt the SCP to the individual application it is necessary to make the following adjustments on the module circuit board with links.

- Jumper J1, position of decimal point on the digital display or parking position when no decimal point is required.
- Wire link IN X, input signal from system bus AV 1 - 16. This link must be placed on the same bus line to which the output of the pressure amplifier or flowmeter has been connected (pressure or flow signal).
- Wire link O Y f (output Y signal, filtered), filtered actuator output signal to system bus AV 1 - 16. This link is only made if the Y signal can be used as measurement. For example, when using a roller pump in the control system there is a linear relationship between this signal and the pump flow rate. After volumetric calibration of the pump, a particular flow rate can be assigned to the signal which can be calibrated. The signal O Y f is influenced by the setting of the switch „FILTER 0.3 - 1- 0.1“ on the frontpanel.
- Wire link O Y uf (output Y signal, unfiltered), unfiltered actuator output signal to the system bus AV 1 - 16. The explanation is the same as above for O Y f but the signal is not influenced by the setting of the switch „FILTER 0.3 - 1- 0.1“.

IMPORTANT: when selecting the pin AV 1 - 16 it is essential to ensure that the selected bus line is not being used by the output signal of another module. Check this in the bus diagram contained in the manual supplied with the PLUGSYS® housing.

Do not forget: enter the selected bus connections (AV 1-16) in the bus diagram (see above) contained in the PLUGSYS® manual.



Position of the links on the printed circuit board

10.0 Maintenance notes

WARNING: for safety reasons pull out the supply plug before carrying out any cleaning operations on the unit!

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

For cleaning never use scouring powder or any cleaning agents which attack plastics.

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

Heavier dirt can be removed with a soft cloth moistened with soapy water or a mild domestic cleaning agent. Then wipe up with a cloth moistened with clean water. Never allow any liquid to find its way inside the unit. Protect also the controls on the front panel and on the back of the unit against ingress of liquid.

Any spots on the front panel can usually be removed with an ordinary plastic eraser.

11.0 Transport

If you have to ship the module (e.g. for repair), note the precautions in Section 8.2 before removing the module from the housing. Place it first in a plastic bag with ESD protection (slightly electrically conducting plastic foil) or wrap it in packing paper. Then pack the wrapped unit inside a strong carton large enough to provide at least 10 cm space all round, and pad the unit well all round with a soft material (foam plastics, cellulose, paper ...). Mark the carton that its contents are fragile.

12.0 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.

14.0 Technical data

Unit designation:	Servo Controller for Perfusion (SCP)
Function:	electronic PID controller for physiological and pharmacological research
Construction:	PLUGSYS® module
Input signal:	0 - 10 V via system bus
Control gain:	1x - 50x
Differentiation factor:	0.1 - 100
Integration factor:	0.05 - 10
Control output signal:	0 - 10 V
Ambient conditions:	laboratory indoors
Operating temperature:	15 - 35°C
Storage temperature:	-10 to 50°C
Relative humidity:	20 - 80%, no condensation
Supply:	5 V DC, 0.3 A from PLUGSYS®
Dimensions:	19" PLUGSYS® module / width 8 E (40.5 mm) / height 3 U (128.7 mm) / depth Eurocard (220 mm)
Weight:	0.3 kg

15.0 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

16.0 Index