Commissioning guideline for PAM-198-P

Contents

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Date: 25.11.2019

Please refer to the general product documentation for more detailed information and safety instructions.

1 Scope of application

The power amplifier PAM-198-P is used to drive valves with position control of the spool. Some settings are required to adapt this unit to a specific valve series. A good result can only be achieved if these settings are carried out systematically and in the correct order.

Later changes to parameters of a previous step are not recommended.

This manual is intended as a supplement to the product documentation. There you will find a detailed description of all setting options and further information such as technical data and connection diagrams. In this manual, only the most important parameters are addressed, which must be set for good functioning. The module also provides a number of additional options, such as free characteristic linearization.

2 Cabling and electrical interfaces

Reference can be made here to the AN-105-EN, which can be found at

https://www.w-e-st.de/en/service/pdf-downloads/

3 Variants of valves and actuating systems

The PAM-198-P is basically suitable for the following constellations:

- - Direct operated directional control valves with two solenoids
- - Directly operated directional control valves with one solenoid
- - Pilot operated directional valves with barometric adjustment, i.e. pressure valves are used to position the main stage spool against return springs.
- - Pilot operated directional control valves with a main spool actuation in the form of a follower piston

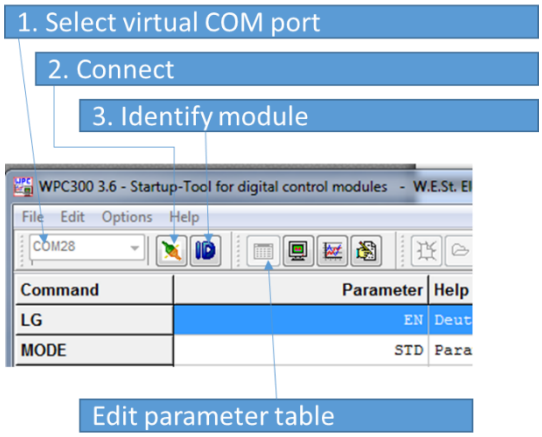
A common characteristic of these cases is that they are controlled systems with compensation, i.e. there is a clear, albeit not necessarily linear and precise relationship between the solenoid actuation and the spool position. Such valves are referred to as "Type I" in the following.

On the other hand, regulated systems without compensation have an integrating behaviour. With constant activation (non-zero), the controlled variable changes more and more. An example of this is the positioning of a main stage using a directional valve for pilot control. These valves are referred to in the following as "Type II".

In general, an electrical feedback of the spool travel position is necessary for full utilisation of the possibilities. However, the device can also be operated as a pure power amplifier (CTRLMODE OL). With Type II valves, this is necessary during adjustment, but later in regular operation a purely open loop control cannot provide any useful behaviour with these valves.

4 Establishing a connection with the WPC

1. If the module is supplied with power, a connection with WPC can be established.
2. Select virtual COM interface (if necessary, check in the device manager whether the latency time of the COM interface is set to 1 or 2 ms).
3. Connect (only the COM port is opened, no communication takes place yet)
4. Identify (the parameter table is read in)



Attention: If no connection can be established, a wrong COM interface has usually been selected or the USB/COM driver has not been installed. Pull the plug on the module and reconnect it. Observe on your PC whether the driver is being installed and which COM port is added.

5 Step 1: Pre-parameterization

Here, settings are first made on the basis of the general system properties and data sheet values. The hydraulics should first be switched off so that any settings can be carried out safely. Please also note that the unit can become active now if the external signals demand it. It is therefore recommended not to activate the external "ENABLE" signal at first or to temporarily disconnect the wire at terminal 15.

The following parameters must now be set:

Command	Parameter	Description	Group
LG	DE|EN	Choose your preferred display language	-
CTRLMODE	OL|CL	For the next steps it is necessary to change first to "OL" = open loop controlled mode.	**SYSTEM**
SENS	ON|OFF|AUTO	Decide how the device should behave in the event of a fault.	**SYSTEM**
AIN:W	a/b/c/x	Adjustment of the setpoint input	**IO_CONF**
SIGNAL:U	1S+|1S- 2S+|2S-	Is it a valve with one or two solenoids? The polarity is first assumed to be "+".	**IO_CONF**

CURRENT	500… 2600	Enter the nominal current of the valves here. If this is less than 500 mA, you can use the parameters VA:MAX:A/B to further reduce the output current.	**PAM**
DFREQ DAMPL PWM	60… 400 0… 3000 61… 2604	Utilize data sheet information of the valve .[1]	**PAM**
C:FF	0… 20000	First set to the value "10000" = 100%. The final setting follows in step 3.	**CTRL**

Checks at the end of the step (optional):

See the monitor window of the WPC to verify that the WA setpoint is transferred correctly.

Activate the RC mode in the WPC and check whether the solenoid actuation works. Check the box "ENABLE". The READY LED should light up. If this is not the case, an error is displayed above the red LEDs, which must first be corrected.

By clicking in the field WA (number turns red) you can now set the setpoint between -10000 (= -100%) and 10000 (= 100%) using the slider.

Since the module works in "OL" mode, i.e. purely controlled, this value is passed almost unchanged as manipulated variable "U".

It is now possible to control both solenoids with their nominal current. This applies to 2 - solenoid valves. If you have parameterised a single solenoid valve, you can adjust its control in the range 0 - 100% by moving WA between -10000 (= -100%) and 10000 (= 100%).

[1] There are two basic principles:

1. The coil is driven with the highest possible PWM frequency in the kHz range and an additional dither signal. This is the predominant variant in industrial hydraulics.

2. In the mobile sector, valves are mainly used which are controlled with a low PWM frequency. In this case no DITHER signal is used. It is not necessary to use the exact PWM frequency, therefore the input for our devices is done in steps by selecting from a table. The nearest setting should be selected.

Attention: The information in the data sheet on this subject is often incomplete or misleading, as the terminology is frequently confused. If there is only a frequency specification, the PWM setting is usually meant. If the DITHER signal is referred to, there is usually an indication of frequency and amplitude. If there are no instructions, it is recommended to use the factory settings.

6 Step 2: Scaling the position sensor

The spool travel is usually measured via an LVDT displacement measuring system. Since the device is not able to process the raw signal of such a sensor, an external evaluation electronics is necessary. This can also be integrated directly into the sensor.

The output signal of the sensor is proportional to the spool travel. It is often possible to adjust the zero point and gain at the sensor or its evaluation electronics. It is the basic decision at which location an individual adjustment should take place. If an entire valve series is to be operated with a single parameter set, it makes sense to carry out an adjustment on the displacement transducer; for individual applications, this can also be done using the AIN:X command. Both procedures are described below.

a.) Adjustment at the position transducer

It is defined which output signal range is used and where the zero point of the signal should be (corresponding to the neutral position of the spool).
On the basis of these definitions, the AIN:X command is used to prepare the module accordingly. This is described in detail in chapter 5.3.1 of the device documentation.
Example: The sensor is to be adjusted so that it outputs a voltage of 4 V in the middle position, 1 V at full deflection to "B" and 7 V at full deflection to "A": C (offset) = 4000, B (divider) = 300 (3 V for 100%), A remains 1000.

To set the zero point and the gain at the sensor, the valve must be activated and the read signal displayed. To do this, use the RC mode as described in the previous chapter. The actual position of the spool is indicated by the process variable "X". If the scaling is correct, the following situation should result:

2 - solenoid valves	WA = U = 0 -> X = 0 (only for type I) WA = U = 100% -> X = 100% WA = U = -100% -> X = -100%
single solenoid valve	WA = U = 100% -> X = 100% WA = U = -100% -> X = -100% The zero point of single solenoid valves cannot be found by the electrical signals alone, as there is no centering of the spool. One possibility is to search for the hydraulic zero point with oil flow.

Zero point for Type II valves (controlled system without compensation):

If the valve is equipped with spring centering, the zero point can be set in the completely depressurized state. Otherwise, the position control must first be set provisionally (see step 4), then you can search for the hydraulic zero point with oil flow.

To adapt the signal, an adjustment is carried out on the displacement transducer.

It should be noted that signals greater than 100% and less than -100% are cut off, i.e. it is better to set it to +/- 99%, since at 100% you cannot be sure whether the signal has been limited.

If the system behaves exactly the other way round (-100% X at U = 100%), you can either replace the valve leads or set the parameter U to negative polarity (1S- or 2S-).

b) Adjustment using the scaling function AIN:X

Procedure similar to that described in the product documentation:

- Select standard setting 1000 / 1000 / 0 / V or 1000 / 1000 / 0 / C (current range 0-20 mA)
- Multiply displayed value X in zero point (in %) * 100 and enter it at C (e.g. 1000 / 1000 / 5120 / V)
- Actuate with +100% (see above), write down X value
- Actuate with -100% (see above), write down X value
- Take the larger value * 10 and enter it for B (e.g. measured is -26.8 % and 25.1 % -> B is set to 268)
- Check whether approx. -100 ... 0 ... 100 % are reached.

With regard to polarity, the statement under a) applies.

Zero point for Type II valves (controlled system without compensation):

If the valve has spring centering, the signal at the zero point can be used in a completely depressurized state. Otherwise, the mean value of the signals in both end positions should be used first. After setting the controller, you can then search for the hydraulic zero point and correct it if necessary.

7 Step 3: Set minimum control or offset and feed forward control

In order to compensate the dead zone by the spring preload with 2 - solenoid valves, a minimum drive must be specified. The value is set separately for both directions and is easy to determine:

Use the RC - mode as above, slowly increase the control with the slider for WA and observe the actual value X. Find the point at which the display for X begins to increase noticeably with a further increase of WA. Note the control signal U at this point. The same must be repeated for the other direction to negative values for WA and X. The value found there for U is also noted. Then set the two parameters VA:MIN:A and VA:MIN:B in the group "IO_CONF": Direction A for the positive, B for the negative signal direction. Enter the values of the minimum activation (*100, since the entry is made in 0.01%).

It is possible to round off the value generously, but do not enter values that are too large, otherwise the control will not work in the range around the zero point.

In the case of single solenoid valves, an adjustment of the OFFSET is necessary at this point, i.e. the control that brings the spool into the neutral position. In RC mode WA must be set to "0", ENABLE is still necessary.

Now set the parameter VA:OFFSET in the group "IO_CONF" so that the spool position "X" reaches the zero point as well as possible.

Feedforward control (Type I):

This parameter is very important. The better the feedforward is set, the less the controller has to "work".

Select at least the two process variables X and C (= controller output) in the monitor.

Slowly move the slider to both end positions using the RC mode over the setpoint WA.

Record the values of C at which the full deflection of the slider is reached in both directions.

Here you can also consider the hysteresis, i.e. the values at which the return movement starts, can also be recorded when the signal is lowered. An average value of the values of the signals "C" determined in this way must be entered in the parameter C:FF in the group CTRL (take x 100 again).

Type II valves:

The procedure for setting the minimum control is similar, but the integrating behaviour of the controlled system must be considered. As soon as the slider of the main stage reaches one of the two end positions, first move it back into the working range. A certain drift will also be noticeable if the control is removed. We are looking for the points at which a significant increase in speed occurs. If you control a single solenoid valve of type II, try to set the OFFSET parameter to a state of minimum drift. To do this, set the parameter C:FF to "0" and move the spool only by changing this parameter.

Even with 2 solenoid Type II valves, the minimum control C:FF must be set to "0" after setting the minimum control, as feedforward control makes no sense in regular operation.

8 Step 4: Optimize position controller

Now it is time to leave the open loop mode and activate the controller. To do this, set the CTRLMODE parameter in the "SYSTEM" group to CL.

Attention: If the controller is activated and incorrectly set, the control may become unstable, resulting in strong vibrations. If something like this occurs, remove the "ENABLE" signal and reduce the controller gain before trying again.

In the group CTRL a number of further parameters are displayed which have to be set in the correct order.

First set C:I_LIM to "0" to suppress the integral part of the controller.

The oscilloscope view in the WPC is useful for evaluating the transient response.

The signals of interest are: X (slider position), W (setpoint value), C (controller output), E (control deviation)

In order to observe the transient response, it is necessary to have the oscilloscope window open during a signal change. If you use WPC < version 4.0, this is only possible with external signal input for W and ENABLE. To achieve setpoint jumps with steep slopes, the ramp times in the "ADAPT" group should first be reduced to the minimum value of "1" (parameter RA:1 ... RA:4).

Setpoint jumps are caused by rapid changes in the analog setpoint signal or by switching on the ENABLE.

The following illustration shows a good transient response:

In comparison, an unstable controller setting:

The easiest way to adjust the proportional gain is to gradually increase C:P until instability occurs. The value of C:P is then divided by 2-4 to obtain a definitely stable but high value.

If possible, a test with oil flow should also be carried out at this point, since the behaviour can change due to the flow forces and their dynamic components.

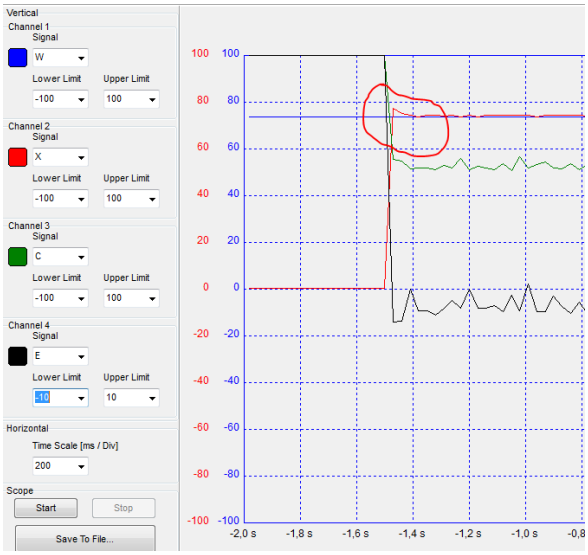
Type I:

After setting the proportional gain, the integral component can be activated. First parameterize a large integral time, i.e. a weak I component: Set C:I e.g. to 5000.

The first thing to do now is to find the lowest possible limitation by C:I_LIM, but which is sufficient to compensate for permanent control deviations, regardless of the operating situation.

Therefore, first increase C:I_LIM e.g. to 2000 (= 20%) and carry out tests with different controls with and without oil flow. Observe whether the control deviation "E" will only fluctuate around the zero line after reaching steady-state operation. If this is not the case in some points, but C is not yet 100% or -100%, increase C:I_LIM.

The next step is to set the reset time C:I to an optimum value. This means: As small as possible, but without tendency to oscillate and with little overshoot. Another undesirable effect with too small reset times can be that due to the fast reaction but asymmetrical signal limitation a permanent control deviation may occur.



Here one can see an undesirable overshoot!

Type II:

In most cases, the integral component can remain deactivated, since the controlled system already has integrating behavior. If, however, a too high control deviation is detected without integrator, it can be set in a similar way as described above. However, a much lower value must be set for C:I_LIM (typ. maximum 5%).

Now the most important control parameters are set.

The following may still be useful depending on the application:

- Activate differential part (this sometimes allows a higher P - amplification), but is often problematic
- Adjust the dead band for the integrator (C:I_DEACT) if the spool cyclically oscillates through the I component during stationary operation (occurrence of so-called limit cycles).
- Set the activation threshold for the integrator if an overshoot cannot be eliminated by a reasonable increase of C:I in the case of setpoint changes. (does not apply to type II, leave C:I_ACT at "0" there).

9 Step 5: Adjust setpoint preprocessing

Now that the spool position control is working optimally, the next steps are to adapt the system to the application.

In step 3, the part of the dead zone resulting from the spring preload has already been compensated. Now the remainder can be compensated, which results from the overlapping of the control edges at the spool.

To do this, determine the values of the input signal WA in both directions required to start the flow through the valve.

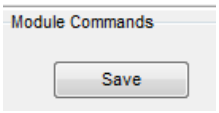
Enter the amounts of these values in the group "ADAPT" in the parameters MIN:A / MIN:B (as usual * 100).

If you still want to limit the maximum flow, or if you want to achieve symmetrical speeds of the actuator in both directions, the parameters MAX:A / MAX:B can be used.

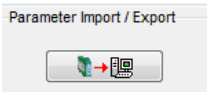
Depending on the application, it is advisable and necessary to limit the speed of the adjustment:
If the valve is to serve as an actuator in a higher-level control loop, limitation is usually not desired. Leave the parameters RA:1 ... RA:4 at the value "1" = minimum setting, as set in the last step.
If the setpoint is given manually, the values of the factory setting (100 ms) are good starting points which can be increased further depending on the application. For more information on the exact function of the 4-quadrant ramp, refer to the corresponding chapter in the product documentation.

10 Step 6: Completion of the work

Once all settings have been made, save the settings in the non-volatile memory of the module using the SAVE command:



In addition, we recommend saving the parameters in a file:



This allows you to save the settings independently of the module and transfer them to other devices if necessary.

11 Further information and support

As mentioned at the beginning, all functions are described in detail in the technical product documentation of your device.
If problems occur or additional functions are required, please read this document first.
If further help is required, please contact us at technics@w-e-st.de or the telephone number given.
Please describe the exact circumstances in an understandable way and enclose this:

- Set parameters as *.wpc – file
- Screenshots of the WPC monitor window and the oscilloscope view

Another very effective way for support is a remote access to your computer via the program TeamViewer.